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NIAGARA 1987

AIR QUALITY SURVEY IN THE VICINITY OF THE MIST OF HORSESHOE FALLS JUNE 1987

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Ontario

Ministry
of the
Environment

The Honourable
Jim Bradley
Minister

Rod McLeod
Deputy Minister

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NIAGARA 1987
AIR QUALITY SURVEY
In the Vicinity of
the MIST of HORSESHOE FALLS

June 1987

ARB - 130 - 87 - ARSP

Prepared for

West Central Region
Ministry of the Environment
&
The Niagara River Improvement Programme

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Ministry of the Environment

September 1987

Executive Summary

At the request of the West Central Region and the Niagara River Improvement Programme of the Ministry of the Environment, Mobile Air Monitoring Units #1 and #3 (TAGA) of the Air Resources Branch conducted an air monitoring survey during the week of June 15 in Niagara Falls, Ontario. This survey was undertaken in response to the reported results of a theoretical study conducted at the University of Toronto that suggested large amounts of toxic chemicals such as polychlorinated biphenyls (PCBs), chloroform and chlorinated benzenes could be evaporated into the air from the Niagara Falls mist and as such, could affect the environment in the vicinity.

No field measurements had ever been made to confirm these modeling results. Thus this survey was requested and the objective was to locate the mobile air monitoring units in the mist, or downwind of the mist, originating from Horseshoe Falls, to provide on-site measurements of ambient air concentrations of PCBs, chloroform, chlorobenzenes and other gaseous contaminants.

From the data acquired during this survey, no concentrations of PCBs, chloroform or chlorobenzene were detected above the detection limits of the pertinent analyzers (0.10 micrograms per cubic metre (ug/m^3) for total PCBs; 2.2 ug/m^3 for chloroform; and 0.4 ug/m^3 for chlorobenzene). In addition, no applicable Ministry of the Environment Air Quality Criteria, Guidelines or Provisional Guidelines were exceeded for any of the contaminants measured. Concentration levels of all organic compounds detected in the mist were low and typical of an urban environment.

Sommaire

À la demande de la Région du Centre-Ouest et des autorités chargées du Programme d'amélioration de la rivière Niagara (Ministère de l'Environnement), les Unités mobiles n^{os} 1 et 3 de surveillance de l'air (Analyse des gaz atmosphériques à l'état de trace), qui relèvent de la Direction des ressources atmosphériques, ont analysé l'air à Niagara Falls (Ontario) pendant la semaine du 15 juin. L'analyse a été exécutée par suite de la publication des résultats d'une étude théorique menée par l'Université de Toronto, selon laquelle de grandes quantités de produits chimiques toxiques, tels que des biphényles polycholorés (BPC), du chloroforme et des benzènes chlorés, pourraient s'évaporer dans l'air après y avoir été transportés par les embruns des chutes du Niagara et, ainsi, nuire à l'environnement des régions voisines.

Aucune mesure concrète n'avait jamais été faite pour confirmer ces résultats théoriques. On a donc demandé l'exécution d'une analyse dont l'objectif consistait à placer les unités mobiles de surveillance de l'air dans les embruns, ou sous le vent par rapport aux chutes du Fer-à-cheval, de façon à mesurer sur place les concentrations de BPC, de chloroforme, de chlorobenzène et d'autres contaminants gazeux dans l'air.

Les données ainsi recueillies ont montré que les concentrations de BPC, de chloroforme ou de chlorobenzène ne dépassaient pas les limites de détection propres aux analyseurs pertinents (0,10 microgramme par mètre cube (ug/m^3) pour l'ensemble des BPC; 2,2 ug/m^3 pour le chloroforme, et 0,4 ug/m^3 pour le chlorobenzène). En outre, les critères, lignes directrices ou lignes directrices provisoires fixés par le ministère de l'Environnement pour la qualité de l'air ont été respectés dans tous les cas. Les concentrations de tous les composants organiques détectés dans les embruns étaient faibles et typiques d'un environnement urbain.

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1.0 INTRODUCTION

A University of Toronto study, quoted in the Globe and Mail on May 7, 1987, suggested that large amounts of toxic chemicals such as polychlorinated biphenyls (PCBs), chloroform and chlorobenzenes could be evaporated into the air from the Niagara Falls mist. This study, the subject of a Master's thesis and supported by a contract from Environment Canada, was based on a theoretical model which attempted to simulate natural environmental processes as to how volatile chemicals escape from the mist into the air. The input data for this model were drawn from various sources; were heavily qualified by the researchers; and were from different time periods. The study concluded that if the model predictions were accurate, the atmospheric concentrations of these pollutants may affect the environment in the vicinity of the Falls. To-date, there had been no field measurements to confirm the modeling results.

In response to this study, Mobile Air Monitoring Units (MAMUs) #1 and #3 (TAGA) of the Air Resources Branch set out to provide field measurements by conducting an ambient air monitoring survey at the brink of the Falls during the week of June 15, 1987. The purpose of the survey was to provide on site measurements of ambient levels of PCBs, chloroform, chlorobenzene and other volatile organics in the vicinity of the Horseshoe Falls mist.

2.0 METHODOLOGIES AND SURVEY STRATEGIES

2.1 MAMU#1 - GC Methodology,Monitoring & Survey Strategy

MAMU#1 contained a variety of analyzers that enabled screening of the ambient air for 141 different Volatile Organic Compounds (VOCs) and up to 10 Common Contaminants (CCs).

The most versatile analyzer of MAMU#1 was the dual capillary column gas chromatographic (GC) system which was used for the detection, identification and quantification of VOCs. To detect the individual VOCs at the 1 microgram per cubic metre (1 ug/m^3) level, ambient air was drawn through a Trace Organic Preconcentrator (TOP) unit for a set period of time - usually for an one hour duration. In the TOP, the organics were adsorbed onto a Carbotrap-Spherocarb cartridge and then thermally desorbed and prefocused onto a nickel loop cooled to -195°C with liquid nitrogen. The prefocused organics were then flash vapourized and injected simultaneously onto two 25 metre columns (OV-1, SE-54) where the individual organics were separated and detected by flame ionization. Positive identification of the VOCs was assisted by a computer which compared and correlated the results of the two columns with a library established from prior tests.

The other analytical instruments of MAMU#1 were specific continuous analyzers that could measure the following common gaseous contaminants in ambient air.

Oxides of Nitrogen (NO_x)
Nitrogen Dioxide (NO_2)
Total Reduced Sulphur Cpds (TRS)
Total Hydrocarbon Cpds (THC)
Non-methane Hydrocarbons (TH-M)
Nitric Oxide (NO)
Sulphur Dioxide (SO_2)
Carbon Monoxide (CO)
Methane (CH_4)
Ozone (O_3)

A more detailed description of the specific monitoring capabilities of the instruments of MAMU#1 together with the respective detection limits and applicable Ministry of the Environment Standards, Criteria, Guidelines, Provisional Guidelines and the Threshold Limit Values (TLV) are presented in Table #2 of Appendix A.

MAMU#1 also contained a complete ground-based meteorological station which could continuously record wind direction and speed, ambient temperature, humidity, solar radiation and barometric pressure data.

The daily survey strategy for this monitoring unit was to perform calibration checks on the analyzers during the early mornings; acquire upwind environmental data; and then move to a location in the mist or downwind of the mist created by Horseshoe Falls. At these locations, an active ambient air monitoring programme would be followed - i.e. acquire one-hour GC samples and analyze each to see if they contained any of the 141 VOCs; measure the ground level concentrations (glc's) of the 10 CCs; and record the 6 pertinent meteorological parameters.

2.2 MAMU#3 - TAGA Methodology, PCB Monitoring & Survey Strategy

Briefly, the TAGA (Model 3000) is a specialized quadrupole mass spectrometer with an atmospheric pressure, chemical ionization (APCI) source. To monitor PCBs, this ion source is coupled to a PCB preconcentrator and thermal desorption device called an Automated Short Term Adsorber (ASTA). The TAGA/ASTA technique provides ambient PCB measurements in 2-minute intervals, with a half-hour averaged concentration value being computed by averaging 15 consecutive 2-minute samples. During this study, the air was screened for the di-, tri-, tetra- and pentachlorobiphenyl congeners. A more detailed description of this PCB monitoring technique is provided in Appendix B.

Prior to the start of each monitoring day, the TAGA was calibrated for selected PCBs and upwind data were acquired. In addition, single-point calibrations (0.425 ug/m^3 per PCB congener) were randomly conducted each day to confirm the daily sensitivity factors and to determine on-site, the detection limits of the technique. (The detection limit (DL) per congener is defined as being 3 times the standard deviation of the upwind signal, observed at the selected PCB masses, divided by the sensitivity factor. Thus the DL is a function of the TAGA response per unit ug/m^3 and the variation in the levels of chemical interferences present in the upwind samples.) Detection limits for total PCBs (di- to pentachlorobiphenyls as set by this technique) monitored for the individual days were as follows: June 15 (0.10 ug/m^3); June 16 (0.07 ug/m^3); June 17 (0.06 ug/m^3); June 18 (0.11 ug/m^3); and June 19 (0.16 ug/m^3). Thus the detection limits averaged 0.10 ug/m^3 for the 5-day survey. The relative standard deviations for injections of known PCB standards were better than 15% at the 0.425 ug/m^3 level per PCB congener.

The daily survey strategy was to position MAMU#3 in the mist, or downwind of the mist, created by Horseshoe Falls to determine on-site ambient concentration levels of gaseous PCBs every 2 minutes for a period of several hours.

3.0 Discussion of Results

3.1 General Observations

For the analytical treatment of the VOC samples, special emphasis was placed on the chlorinated organics. Of the 141 different ogranics that the GC could identify and quantify in the ambient air samples, 23 were chlorinated alkanes (including chloroform); 9 were chlorinated alkenes; and 7 were chlorinated aromatics (including chlorobenzene).

For the VOCs sampling programme, 15 one-hour GC samples were acquired at the brink of Horseshoe Falls (at Table Rock). With respect to these organics, the Ministry has a number of applicable Standards, Criteria, Guidelines or Provisional Guidelines and these are presented in Table #2 of Appendix A. For the common aromatics (the BTXs), the Ministry of the Environment's Air Quality Criterion (Standard) for benzene is 3,300 ug/m^3 (10,000 ug/m^3); for toluene, 2000 ug/m^3 (2000 ug/m^3); and for xylenes, 2300 ug/m^3 (2300 ug/m^3). For the targetted organics, the Ministry has a point of impingement Guideline for chloroform of 1,500 ug/m^3 for a half-hour average concentration. It also has a 24-hour Criterion for chloroform which is 500 ug/m^3. (Note that if the maximum 1-hour average concentration is less than the Criterion concentration based on a 24-hour average, then that Criterion is not exceeded.) The Ministry of the Environment has no Criterion, Standard or Guideline for chlorobenzene. However there is a Threshold Level Value (TLV) for chlorobenzene (350,000 ug/m^3) which is based on an eight-hour work day.

MAMU#1 acquired air quality data during 11 different monitoring periods (MPs) throughout this week. During these MPs, over 83 hours of continuously monitored common contaminant data were acquired. Of these data: 64.4 hours were acquired at Ontario Hydro's Water Intake Station #2 (four overnight monitoring periods - 4MPs); 17.9 hours were acquired in the mist at the brink of Horseshoe Falls (6 MPs); and 0.9 hours were acquired south of Chippawa at the Niagara South Recreation Centre (1 MP).

For the PCB monitoring programme, a total of 405 2-minute air samples were screened for PCBs using the mobile TAGA/ASTA technique. Simultaneous measurements of 4 targetted PCB congeners were possible by this technique: the dichlorobiphenyls, trichlorobiphenyls, tetrachlorobiphenyls and pentachlorobiphenyls. The results of fifteen·consecutive 2-minute samples were averaged to yield the half-hour average concentrations for total PCBs. Tables #1 through #5 summarize the PCB monitoring results from this survey and they are presented in Appendix C.

Occasionally chemical interferences at the same nominal masses as PCBs were noted during some of the half-hour averages. Measurements indicating interferences are flagged with the letter 'i' in Tables #1 to #5 of Appendix C. However the calculated levels of chemical interference were only slightly above the detection limits. These interferences are not indicative of the presence of PCBs since the data did not meet the criteria for identification of PCBs (See Appendix B).

It should be noted that atmospheric conditions for monitoring during the entire survey were ideal: light to moderate winds and ambient temperatures in excess of 20°C. The mist was always present and the monitoring units were either in or directy downwind of the mist.

3.2 Daily Synopses

June 15

A high pressure area was located just to the west of Lake Superior. A weak west-east orientated cold front moved through the Niagara area overnight and the air mass behind this front was dry and stable. It was a sunny day with temperatures in the mid to high twenties. The winds were light and northerly.

MAMU's #1 and #3 arrived in Niagara Falls during the late-morning. They were immediately driven to Table Rock at the brink of Horseshoe Falls. The mist from this Falls was in the immediate area and thus both MAMU's were prepared for the acquisition of air quality data. MAMU#1 was placed on shoreline power (an external electrical power source) and positioned just to the north of the restaurant/gift shop complex. MAMU#3 operated on generator power and was positioned 25 metres to the north of MAMU#1. Both MAMU's were approximately 25 metres from the gorge and 100 metres from the brink of the Falls.

Ministry staff members from the West Central Region, the Niagara River Improvement Programme and the Communications Branch met with the Air Resources Branch staff members at noon. An Open House and Press Conference was held at 2pm to explain the purpose of the survey and to answer any questions from the press or public.

After calibrations, the instrumentation of MAMU#1 commenced acquiring air quality data at 12:48pm - please refer to MP A151 (Table 4, Appendix A). Approximately 3.7 hours of CCs data were acquired and these results are presented in Table 4 of Appendix A. In addition, 3 one-hour VOCs samples were acquired and these results are presented in Table 5 of Appendix A. From these data, all ground level concentrations (glc's) were low. The concentrations of CCs were typical of an urban environment and the VOCs were in the range of 30 to 40 ug/m^3 with the alkanes accounting for 54% and the aromatics 36% of these totals. A maximum of 40 different organics were detected in these three samples but the individual concentrations were all less than 5 ug/m^3. No chloroform or chlorobenzene was detected in any of these samples and the most dominant aromatic was toluene with an average concentration of 3.5 ug/m^3.

After 4:30pm, MAMU#1 was moved to its overnight monitoring site at the Ontario Hydro Water Intake Station #2 located approximately 2.5 km southeast and upstream of Horseshore Falls. At 5:25pm, an overnight monitoring programme was started. Only common contaminant and meteorological data were acquired during these overnight programmes. From the results of this particular programme (refer to MP A152), over 15 hours of CC data were acquired; all glc's were low; and no Ministry of the Environment Air Quality Criteria were exceeded.

With respect to MAMU#3, this day was dedicated to conditioning the TAGA and establishing the appropriate monitoring locations. A calibration was performed and two half-hour samples were collected. The two half-hour samples were acquired in the parking lot of the Table Rock gift shop (Map #1, site A of Appendix C). As noted in Table #1 of Appendix C, no PCBs were detected above the analytical detection limit of the TAGA as determined for that day - i.e. 0.10 ug/m^3. It is noteworthy that the two half-hour samples were collected in a light, intermittent mist, even though the meteorological data suggested a westnorthwesterly wind. In this instance, the wind direction was not of extreme significance due to the close proximity of the monitoring unit to the Falls and the influence of the buildings at Table Rock.

June 16

A ridge of high pressure lying from Lake Michigan to Lake Erie was forecasted to weaken as the day evolved. The air mass over Niagara Falls was dry and stable and the winds were southwesterly and moderate (up to 10 or 15 km/hr). It was a sunny day and the ambient temperature approached 30°C.

All instruments in MAMU#1 were calibrated before 9:30am and MAMU#1 moved to Table Rock shortly thereafter. Starting at 9:52am, over 2 hours of common contaminant air quality data (MP A162) and 2 one-hour VOC samples were acquired. As noted from Table #4 of Appendix A, all glc's of the CCs were low. For example, the maximum one-hour average glcs of CO, NO_2 and O_3 were 0.67, 0.02 and 0.03 ppm respectively. As shown in Table 5 of Appendix A, the VOCs averaged only 68 ug/m^3 with the alkanes comprising 71% of these totals and the aromatics 20%. Thirty-eight and 35 different organics were detected in these two VOC samples and the field GC library accounted for over 80% of the total peak area . The maximum concentration for an individual organic was 18 ug/m^3 (butane). The majority of the organics were the low boiling alkanes (propane through hexane). Toluene was the dominant aromatic at concentrations of 3 and 4 ug/m^3. No chloroform or chlorobenzene was detected.

After 3:30pm, MAMU#1 moved to the overnight monitoring site at Water Intake Station #2. At 4:03pm, an overnight monitoring programme commenced (MP A165). From the 17 hours of CCs data, low concentrations were measured and no Environmental Criteria or Guidelines were exceeded. (See Table 4, Appendix A)

All downwind monitoring performed by MAMU#3 on this day was conducted in front of the Victoria Park Restaurant on the Niagara Parkway (See Map #1 - Site B, Appendix C). A total of seven half-hour samples were recorded at this location. During the first two samples the mist was intermittent. For the remaining samples however, the mist was quite steady. Table #2 (Appendix C) summarizes the data pertaining to this day and as with each of the monitoring days, PCBs were not detected above the daily analytical detection limit.

June 17

A high pressure area was centred over Georgian Bay and was forecasted to move slowly eastward. The air mass over Niagara was dry and stable and it was sunny and clear. The ambient temperature was in the mid-twenties and the winds were easterly and moderate (up to 15 km/hr).

After the morning calibration work at Water Intake Station #2, MAMU#1 moved to the southwest corner of the Table Rock restaurant/gift shop complex. The mist was heavy and commencing at 10:50am, 1.3 hours of CC data were acquired (reference to MP A172). Low glc's of NO_2 and O_3 were measured (0.02 and 0.03 ppm respectively for a maximum one-hour average concentration). However slightly higher glc's for CO and THC were measured. The maximum one-hour average glc for these two contaminants were 1.99 and 1.67 ppm respectively. The winds were swirling because of the buildings and the mist was sporadic throughout a large area centered at Table Rock. By noon, the winds had veered slightly and the mist was impinging at the north end of this complex. No VOC sampling was carried out at this site as calibration work continued on the GC system.

MAMU#1 moved to north end of this complex and commencing at 12:20pm, 4.5 hours of CC data and 3 one-hour VOC samples were acquired. For the CC data, low concentrations were measured for CO, THC, NO_2 and O_3. The overall average glc's for these 4 gaseous contaminants were 0.22, 1.48, 0.01 and 0.03 ppm respectively. The winds continued to swirl and during the first hour of monitoring at this site, some emissions from the local traffic along the Niagara Parkway were measured. This was reflected by the wind direction at the time of maximum readings for the CCs and the analyses of the 12:20pm VOC sample. The total VOC concentration was found to be 112 ug/m^3 with the alkanes comprising 69% of this total (or 77 ug/m^3) and the aromatics 17% (or 19 ug/m^3). Fifty-one different organics were detected and the individual concentrations were all less than 15 ug/m^3 with the more dominant organics being the low-boiling alkanes (propane to hexane). From the two other VOC samples, the number of specific organics identified dropped to 31 and the total organic concentrations were light at 28 and 14 ug/m^3. Good confirmations were achieved on these three VOC samples as the field GC library accounted for approximately 80% of the total peak areas.

At 5pm, MAMU#1 returned to Water Intake Station #2 and was prepared for overnight monitoring (MP A174). Commencing at 5:17pm, 15 hours of common contaminant data were acquired and all glc's were found to be low.

MAMU#3 began sampling at 7:17am with upwind monitoring at Water Intake Station #2. Once the calibration was completed, the MAMU was relocated to the southwest corner of the parking lot of the Table Rock restaurant/gift shop complex (See Map #1 of Appendix C - Site C). Eight half-hour samples were gathered at this site, plus two single-point PCB calibrations were performed. Again PCBs were not detected above the detection limit during any of the monitoring periods. Data from June 17 have been summarized in Table #3 of Appendix C.

June 18

A weak, northeast-southwest orientated cold front was located over the western half of Lake Superior and was forecast to move slowly eastward to lie over Lake Huron early Friday. The weather of Niagara was still being influenced by the previous high pressure area which had now moved into New York State. The air mass in Niagara was dry and stable and the winds were light northeasterly. It was a clear, sunny day and the mist from Horseshoe Falls was impinging at Table Rock.

After the morning calibration work at Water Intake Station #2 MAMU#1 moved west of Chippawa and set up in the parking lot of the Niagara South Recreation Centre. Commencing at 9am, 0.9 hours of CC data and a single one-hour VOC sample were acquired. The VOC sample and the CC data (MP A181) were deemed to be indicative of an urban environment. As can be seen from Table #4 in Appendix A, low glc's for the common contaminants were measured. As noted in Table #5 of Appendix A, the total organic concentration determined from the VOC sample was 84 ug/m^3.

After 10:30am, MAMU#1 moved to Table Rock. Commencing at 11:45am, 3 hours of CC data (MP A183) and 2 one-hour VOC samples were acquired. Low concentrations were determined for the common contaminants (see Table #4) and the organics (see Table #5). The respective maximum one-hour average glc's for CO, NO_2 and O_3 were

0.57, 0.02 and 0.06 ppm and the total VOCs were 55 and 46 ug/m^3.

At 3:00pm, MAMU#1 returned to Water Intake Station #2 and was prepared for overnight monitoring (MP A185). Commencing at 3:57pm, 16.8 hours of CC data were acquired. Despite a nocturnal inversion during the early morning hours, the concentrations of the common contaminants remained low. The maximum one-hour average glc's for CO, NO_2 and O_3 were 1.00, 0.05 and 0.05 ppm respectively.

With respect to monitoring activities of MAMU#3, upwind data for this day were collected at Water Intake Station #2 at 7:00am. Following the calibration procedures, MAMU#3 was positioned at Site A (See Map #1 of Appendix C). Table #4, Appendix C details the activities of this day and once again illustrates that no PCBs were detected above the analytical detection limits for any of the seven half-hour samples. The mist on June 18 varied in its intensity at the sampling location. During the first two half-hour samples, the mist could be described as light, but constant. While the mist remained light for samples 4-3 and 4-4, it should be noted that wind speeds decreased (ranging from 0-5 km/hr). For the final three half-hour samples on this day, the mist has been described as light to nil.

June 19

The aforementioned weak cold front had pushed into Lake Huron. The air mass over Niagara was becoming moist and unstable. The winds were light and variable in the morning but became northwesterly and moderate (up to 10 km/hr) by noon. The sky cover was broken to overcast with the ambient temperatures in the high twenties by mid afternoon.

After terminating the overnight monitoring programme (MP A185) at Water Intake Station #2, the MAMU#1 moved to Table Rock and was positioned in the mist from Horseshoe Falls. Commencing at 9:06am, over 3 hours of CC data and 2 one-hour VOC samples were acquired. As noted from Tables #4 (MP A191) and #5 (Appendix A), low concentrations for the common contaminants and the organics were measured. The overall average glc's of CO, THC, NO_2 and O_3 were 0.61, 2.26, 0.03 and 0.05 ppm respectively. Owing to the light northwesterly winds, some vehicular exhaust contamination of the VOC and CC samples was noted. The wind direction at the time of the maximum THC concentration (a maximum one-hour average glc of 2.36 ppm when the wind was from 250 degrees at 3 km/hr) indicated the source as being the Niagara Parkway. The total organic concentration of the first VOC sample was 146 ug/m^3 with the alkanes comprising 64% (93 ug/m^3) and the aromatics 27% (39 ug/m^3). The dominant organics were the low boiling alkanes (propane through to hexane) and the individual concentrations never exceeded 20 ug/m^3. The vehicular exhaust contamination for the second VOC sample was much less and the total organic concentration was 76 ug/m^3.

Calibration of the TAGA and acquisition of upwind data were again conducted in the morning at Water Intake Station #2. Site B, in front of the Victoria Park Restaurant on the Niagara Parkway, was deemed the best location for monitoring the mist. Two half-hour samples were collected at this site in an intermittent, light mist. Table #5 (Appendix C) summarizes the monitoring for this day. Similar to the previous four days of monitoring, the TAGA did not register PCBs above the daily detection limit.

At noon, the air quality survey in the vicinity of the mist of Horseshoe Falls was terminated and shortly thereafter, the mobile air monitoring units left the Niagara Falls area.

4.0 Summary

In response to a University of Toronto study and at the request of the West Central Region and the Niagara River Improvement Programme of the Ministry of the Environment, Mobile Air Monitoring Units #1 and #3 conducted a one-week air quality survey in the vicinity of the Horseshoe Falls mist commencing June 15, 1987. The purpose of this survey was to determine on-site ambient levels of selected polychlorinated biphenyls (PCBs), chloroform, chlorobenzenes and other volatile organic compounds.

The MAMU#1 analyzed 15 one-hour volatile organic samples collected in the mist and recorded 83 hours of common contaminant and meteorological data. The volatile organic samples were screened for 141 different organics.

For the common contaminant data, up to 10 different gaseous contaminants were measured and of the 83 hours of data, 64 hours were acquired at the overnight site (Water Intake Station #2 located approximately 2.5 km southeast and upstream of Horseshoe Falls) and 18 hours were acquired in the mist at Table Rock. Concentration/time analyses for the data acquired at these two sites (Graphs #1 and #2 in Appendix A) clearly show that none of the Ministry of the Environment Air Quality Criteria, Guidelines or Provisional Guidelines were exceeded for any of these contaminants. Furthermore, very little difference was noted in the contaminant levels measured at both locations.

No chloroform or chlorobenzene was detected in any of the 15 VOC samples. All total organic concentrations were low, ranging from 16 to 146 ug/m^3 (an average of 59 ug/m^3). The alkane concentration averaged 37 ug/m^3 (or 63% of the total) whereas the aromatic concentration averaged 16 ug/m^3 (or 27% of the total). The dominant organics were the low-boiling alkanes (propane to hexane) and the common aromatics (benzene, toluene and xylenes). However none of these individual organics had concentrations in excess of 20 ug/m^3. The applicable Ministry Air Quality Criteria, Guidelines or Provisional Guidelines were not exceeded for any of the targetted volatile organics.

In addition , 405 2-minute air samples were screened for selected PCBs using the Ministry's TAGA (Trace Atmospheric Gas Analyzer) unit. None of the 27 half-hour averaged concentrations for PCBs (determined from the 405 samples) exceeded the Ministry of the Environment Guideline of 0.45 ug/m^3 for a half-hour average. In fact, all of the measurements for ambient PCBs were below the TAGA's detection limits which averaged 0.10 ug/m^3 for the 5-day period.

In summary, no exceedances were recorded for any of the applicable Ministry of the Environment Air Quality criteria, Guidelines or provisional Guidelines and the data were found to be typical of an urban environment.

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Mr. L. Shenfeld
Dr. W. Chan

Appendix A ... MAMU#1 and the VOCs and CCs Results

Map #1 --- General Area Map

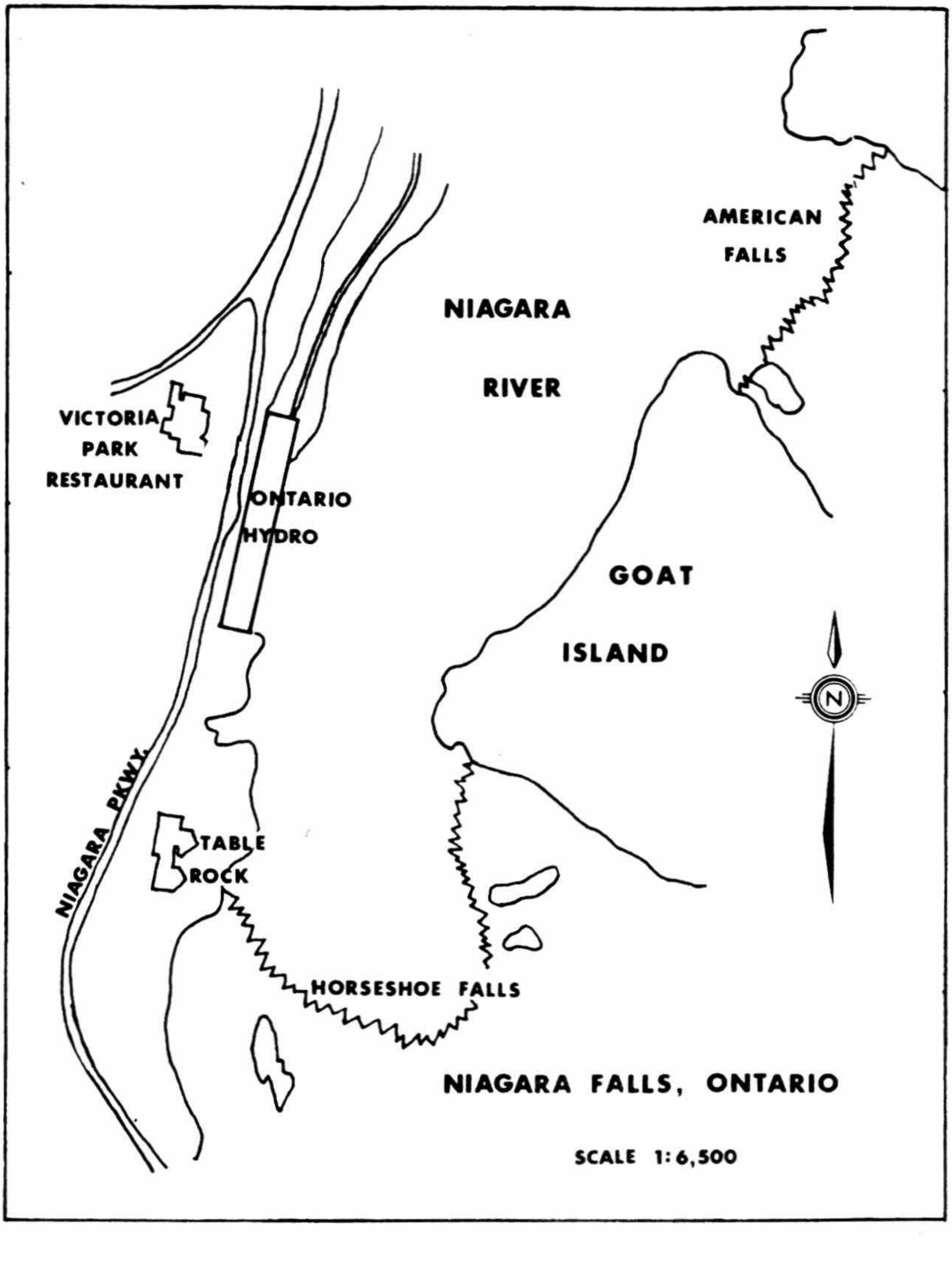


Table 1

THE INSTRUMENTATION OF MOBILE AIR MONITORING UNIT #1

Instrument	Manufacturer	Analytical Technique	Full Scale Sensitivity
THC, CH4, TH-M analyzer	Ingenieur-Produktions-Gruppe Munchen (IPM) RS-t	Dual flame ionization	50 ppm THC (as CH4)
H2S,SO2,NOx sources	Hartmann & Braun Prufgasgenerator	N/A	N/A
TRS/SO2 analyzer	Monitor Labs 8850 c/w ML 8770	Fluorescence	1.0 ppm SO2 0.5 ppm TRS
NOx, NO2, NO analyzer	Monitor Labs 8840	Chemi-Luminescence	1.0 ppm NOx (as NO2)
CO analyzer	Thermo Electron P48	Gas Filter Correlation	100 ppm CO
O3 analyzer/ source	Dasibi 1003-AAS	UV Absorption	1.0 ppm O3
CO & THC sources	Matheson	Compressed Gas	N/A
Gas Chromatograph	HP 5880 Dual Capillary Column	Flame Ionization Det.	as set per calibrations

Meteorological Instrumentation

Instrument	Manufacturer	Scale
** Wind speed	Lambrecht GmBH	km/hr
** Wind direction	Lambrecht GmBH	degrees
Temperature	Weather Measure (WM) T621	degrees Celsius
Humidity	WM-HM-11P	absolute & %
Barometric pressure	WM-BM70-B242	millibars
Solar Radiation	WM Star Pyranometer	milliwatts/cm2

** These instruments are located on top of a 10 metre retractable tower

Table 2a

Characteristics of the Organics Measured by the Gas Chromatographic Systems of MAMU#1

All concentrations are in units of ug/m^3 (micrograms per cubic metre)

	Detection Limits	Standards, Guidelines or Prov.Guidelines	Criterion	Threshold Level Values TWA	Threshold Level Values STEL	Alternate Names
1 PROPANE	0.2					
2 PROPADIENE	0.3					ALLENE
3 PROPYNE	0.3					METHYL ACETYLENE
4 CHLOROMETHANE	0.3	20000 (2)	7000 (A)	105000	205000	METHYL CHLORIDE
5 CYCLOPROPANE	0.3					
6 2-METHYLPROPANE	0.3					ISOBUTANE
7 CHLOROETHENE	0.3	560 (2)	280 (A)	5000	10000	VINYL CHLORIDE; CHLOROETHYLENE
8 2-CHLORO-2METHYLPROPANE	0.3					
9 1-BUTENE	0.3					
10 1,3-BUTADIENE	0.3					
11 BUTANE	0.2			1900000		*n-BUTANE*
12 1-BUTYNE	0.3					ETHYLACETYLENE
13 CHLOROETHANE	0.3			2600000	3250000	ETHYL CHLORIDE
14 3-METHYL-1-BUTENE	0.3					ISOAMYLENE
15 2-METHYLBUTANE	0.3					ISOPENTANE
16 2-METHYL-1-BUTENE	0.3					
17 PENTANE	0.2			1800000	2250000	*N-PENTANE*
18 2-METHYL-1,3-BUTADIENE	0.4					ISOPRENE
19 trans-2-PENTENE	0.2					
20 cis-2-PENTENE	0.2					
21 DICHLOROMETHANE	1.5	100000 (1)	100000 (B)	350000	1740000	METHYLENE CHLORIDE
22 2-METHYL-2-BUTENE	0.3					
23 2,2-DIMETHYLBUTANE	0.2					NEOHEXANE
24 trans-1,2-DICHLOROETHENE	0.3					
25 3-METHYL-1-PENTENE	0.2					
26 4-METHYL-1-PENTENE	0.2					
27 CYCLOPENTANE	0.2					
28 2,3-DIMETHYLBUTANE	0.2					
29 2-METHYLPENTANE	0.2					
30 3-METHYLPENTANE	0.2					
31 1-HEXENE	0.3					
32 cis-1,2-DICHLOROETHENE	0.3			790000	1000000	cis-1,2-DICHLOROETHYLENE; SYM-DICHLOROETHYLENE

Table 2a cont.

Characteristics of the Organics Measured by the Gas Chromatographic Systems of MAMU#1

All concentrations are in units of ug/m^3 (micrograms per cubic metre)

	Detection Limits	Standards, Guidelines or Prov.Guidelines	Criterion	Threshold Level Values TWA	STEL	Alternate Names
33 2-CHLOROBUTANE	0.6					sec-BUTYL CHLORIDE
34 1-CHLORO-2-METHYLPROPANE	0.4					
35 HEXANE	0.3	35000 (2)		180000		*n-HEXANE*
36 CHLOROFORM	2.2	1500 (2)	500 (A)	50000	225000	TRICHLOROMETHANE
37 trans-3-HEXENE	0.3					
38 3-CHLORO-2-METHYLPROPENE	0.3					ISOBUTENYL CHLORIDE
39 METHYLCYCLOPENTANE	0.2					
40 2,4-DIMETHYLPENTANE	0.2					
41 1,2-DICHLOROETHANE	0.2			40000	60000	ETHYLENE CHLORIDE
42 2,2-DIMETHYLPENTANE	0.4					
43 2,2,3-TRIMETHYLBUTANE	0.2					
44 1,1,1-TRICHLOROETHANE	1.0	350000 (1)	115000 (A)	19000000	2450000	METHYL CHLOROFORM
45 1-CHLOROBUTANE	0.4					n-BUTYL CHLORIDE
46 BENZENE	0.2	10000 (1)	3300 (A)	30000	75000	
47 TETRACHLOROMETHANE	0.9	1800 (2)	600 (A)	20000	125000	CARBON TETRACHLORIDE
48 3,3-DIMETHYLPENTANE	0.2					
49 CYCLOHEXANE	0.2	300000 (2)	100000 (A)	1050000	1300000	HEXAHYDROBENZENE
50 2,3-DIMETHYLPENTANE	0.3					
51 2-METHYLHEXANE	0.5					ISOHEPTANE
52 CYCLOHEXENE	0.3			1015000		
53 DIBROMOMETHANE	18.4					METHYLENE DIBROMIDE; METHYLENE BROMIDE
54 1,2-DICHLOROPROPANE	0.6					PROPYLENE CHLORIDE
55 3-METHYLHEXANE	0.5					
56 2,3-DICHLOROPROPENE	0.7			5000	50000	2,3-DICHLOROPROPYLENE
57 TRICHLOROETHENE	0.3	85000 (1)	28000 (A)	270000	1080000	TRICHLOROETHYLENE
58 2,2,4-TRIMETHYLPENTANE	0.2					ISOOCTANE
59 1-HEPTENE	0.3					
60 HEPTANE	0.2			1600000	2000000	*n-HEPTANE*
61 trans-2-HEPTENE	0.3					
62 METHYLCYCLOHEXANE	0.2			1600000	2000000	HEXAHYDROTOLUENE
63 2,2-DIMETHYLHEXANE	0.2					
64 ETHYLCYCLOPENTANE	0.2					

Table 2a cont.

Characteristics of the Organics Measured by the Gas Chromatographic Systems of MAMU#1

All concentrations are in units of ug/m^3 (micrograms per cubic metre)

	Detection Limits	Standards, Guidelines or Prov.Guidelines	Criterion	Threshold Level Values		Alternate Names
				TWA	STEL	
65 4-METHYLCYCLOHEXENE	0.3					
66 2,5-DIMETHYLHEXANE	0.5					
67 1-CHLOROPENTANE	0.4					n-AMYL CHLORIDE; PENTYL CHLORIDE
68 1,1,2-TRICHLOROETHANE	1.1					VINYL TRICHLORIDE
69 2,3,4-TRIMETHYLPENTANE	0.2					
70 TOLUENE	0.2	2000 (1)	2000 (A)	375000	560000	*METHYLBENZENE*; PHENYLMETHANE
71 1,3-DICHLOROPROPANE	0.7			350000	510000	TRIMETHYLENE CHLORIDE
72 2-METHYLHEPTANE	0.2					
73 4-METHYLHEPTANE	0.2					
74 c-1,3-DIMETHYLCYCLOHEXANE	0.2					
75 3-METHYLHEPTANE	0.2					
76 1,2-DIBROMOETHANE	2.1					ETHYLENE DIBROMIDE; ETHYLENE BROMIDE
77 1,1-DIMETHYLCYCLOHEXANE	0.3					
78 1-OCTENE	0.4	150000 (3)	50000 (A)			
79 trans12DIMETHYLCYCLOHEXANE	0.3					*trans-1,2-DIMETHYLCYCLOHEXANE
80 trans-4-OCTENE	0.3					
81 TETRACHLOROETHENE	0.9			335000	1340000	TETRACHLOROETHYLENE; PERCHLOROETHYLENE
82 c-1,4-DIMETHYLCYCLOHEXANE	0.3					
83 OCTANE	0.3			1450000	1800000	*n-OCTANE*
84 trans-2-OCTENE	0.6					
85 cis12DIMETHYLCYCLOHEXANE	0.2					
86 CHLOROBENZENE	0.4			350000		PHENYL CHLORIDE
87 ETHYLCYCLOHEXANE	0.1					
88 1-CHLOROHEXANE	0.5					n-HEXYL CHLORIDE
89 ETHYLBENZENE	0.3	4000 (1)	4000 (B)	435000	545000	
90 m-XYLENE	0.3	2300 (4)	2300 (A)	435000	655000	*1,3-DIMETHYLBENZENE*
91 p-XYLENE	0.3	2300 (4)	2300 (A)	435000	655000	*1,4-DIMETHYLBENZENE*
92 4-METHYLOCTANE	0.3					
93 2-METHYLOCTANE	0.3					
94 3-METHYLOCTANE	0.3					
95 STYRENE	0.5	400 (1)	400 (A)	215000	425000	*ETHENYLBENZENE*; PHENYLETHYLENE; VINYLBENZENE
96 1,4-DICHLOROBUTANE	0.3					

Table 2a cont.

Characteristics of the Organics Measured by the Gas Chromatographic Systems of MAMU#1

All concentrations are in units of ug/m^3 (micrograms per cubic metre)

		Detection Limits	Standards, Guidelines or Prov.Guidelines	Criterion	Threshold Level Values		Alternate Names
					TWA	STEL	
97	o-XYLENE	0.3	2300 (4)	2300 (A)	435000	655000	*1,2-DIMETHYLBENZENE*
98	1,1,2,2-TETRACHLOROETHANE	2.6					ACETYLENE TETRACHLORIDE
99	1,2,3-TRICHLOROPROPANE	1.3			300000	450000	TRICHLOROHYDRIN
100	1-NONENE	0.7					
101	trans-1,4-DICL-2-BUTENE	0.9					
102	NONANE	0.3			1050000	1300000	*n-NONANE*
103	ISOPROPYLBENZENE	0.3	100 (3)	100 (B)			*(1-METHYLETHYL)BENZENE*; CUMENE
104	2-CHLOROTOLUENE	0.3					*2-CHLORO-1-METHYLBENZENE*; o-TOLYL CHLORIDE; o-CHLOROTOLUENE
105	3-CHLOROTOLUENE	0.5					*3-CHLORO-1-METHYLBENZENE*; m-TOLYL CHLORIDE; m-CHLOROTOLUENE
106	4-CHLOROTOLUENE	0.5					*4-CHLORO-1-METHYLBENZENE; p-TOLYL CHLORIDE; p-CHLOROTOLUENE
107	PROPYLBENZENE	0.4					n-PROPYLBENZENE
108	3-ETHYLTOLUENE	0.3					*1-ETHYL-3-METHYLBENZENE*; M-ETHYLTOLUENE
109	4-ETHYLTOLUENE	0.3					*1-ETHYL-4-METHYLBENZENE*; P-ETHYLTOLUENE
110	1,3,5-TRIMETHYLBENZENE	0.4			125000	170000	MESITYLENE
111	2-ETHYLTOLUENE	0.3					*1-ETHYL-2-METHYLBENZENE*; O-ETHYLTOLUENE
112	1,2,4-TRIMETHYLBENZENE	0.4	100 (1)	1000 (A)	125000	170000	PSUEDOCUMENE
113	tert.BUTYLBENZENE	0.3					*(1,1-DIMETHYLETHYL)BENZENE*
114	tert.BUTYLCYCLOHEXANE	0.4					
115	1,3-DICHLOROBENZENE	0.8					
116	1-DECENE	1.3	180000 (3)	60000 (A)			n-DECYLENE
117	(CHLOROMETHYL)BENZENE	4.3					alpha-CHLOROTOLUENE; BENZYL CHLORIDE
118	1,5-DICHLOROPENTANE	0.3					
119	isoBUTYLBENZENE	0.3					
120	DECANE	0.5					*n-DECANE*
121	sec.BUTYLBENZENE	0.2					*(1-METHYLPROPYL)BENZENE*
122	3-(CHLOROMETHYL)HEPTANE	0.3					
123	1,2,3-TRIMETHYLBENZENE	0.4			125000	175000	HEMIMELLITENE
124	1ISOPROPYL4METHYLBENZENE	0.5					*METHYL(4-METHYLETHYL)BENZENE*; 3-ISOPROPYLTOLUENE; P-CYMENE
125	1,2-DICHLOROBENZENE	0.3					o-DICHLOROBENZENE
126	INDAN	0.5					*2,3-DIHYDRO-1H-INDENE*; 2,3-DIHYDROINDENE; HYDRINDENE
127	BUTYLCYCLOHEXANE	0.4					n-BUTYLCYCLOHEXANE; 1-CYCLOHEXYLBUTANE
128	1,3-DIETHYLBENZENE	0.4					m-DIETHYLBENZENE

Table 2a cont.

Characteristics of the Organics Measured by the Gas Chromatographic Systems of MAMU#1

All concentrations are in units of ug/m³ (micrograms per cubic metre)

	Detection Limits	Standards, Guidelines or Prov.Guidelines	Criterion	Threshold Level Values TWA	Threshold Level Values STEL	Alternate Names
129 1,4-DIETHYLBENZENE	0.5					p-DIETHYLBENZENE
130 BUTYLBENZENE	0.3					n-BUTYLBENZENE
131 1,2-DIETHYLBENZENE	0.5					o-DIETHYLBENZENE
132 transDECAHYDRONAPHTHALENE	0.3					t-DECALIN; BICYCLO[4,4,0]DECANE
133 cis-DECAHYDRONAPHTHALENE	0.3					c-DECALIN; BICYCLO[4,4,0]DECANE
134 UNDECANE	0.8					*n-UNDECANE*; HENDECANE
135 1235-TETRAMETHYLBENZENE	0.6					ISODURENE
136 1234-TETRAMETHYLBENZENE	0.6					PREHNITENE
137 1,3-DIISOPROPYLBENZENE	0.8					*1,3-BIS(1-METHYLETHYL)BENZENE*
138 1234TETRAHYDRONAPHTHALENE	0.6					TETRALIN
139 1,4-DIISOPROPYLBENZENE	0.8					*1,4-BIS(1-METHYLETHYL)BENZENE*; ISOPROPYLCUMENE
140 NAPHTHALENE	0.8	36 (3)	22.5 (A)			
141 DODECANE	1.3					*n-DODECANE*

NOTES:
(1) Standard
(2) Guideline
(3) Provisional Guideline
(4) Provisional Guideline for sum of o-, m-, & p-Xylenes

(A) Ambient Air Quality Criterion based on a 24-hour average concentration
(B) Ambient Air Quality Criterion based on a 1-hour average concentration
(please note; if the maximum 1-hour average concentration of a contaminant is LESS than the Criterion concentration based on a 24-hour average, then that Criterion is not exceeded.)

TWA - Time Weighted Average for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed without adverse effect.

STEL - Short Term Exposure Limit - concentration to which workers can be exposed for a short period of time (15 minutes) without adverse effect.

* - Denotes name approved by the International Union of Pure and Applied Chemistry (IUPAC).

Table 2b

Characteristics of the Common Contaminants as Measured Continuously by MAMU#1

All concentrations are in units of ppm (parts per million)

	Detection Limits	Standards, Guidelines or Prov.Guidelines (1/2-hr)	Criterion (1-hr)	TWA	STEL		Alternate Names
1 SULPHUR DIOXIDE	0.01	0.300	0.25	2	5	SO_2	SULFUR DIOXIDE
2 TOTAL REDUCED SULPHUR	0.005	0.027 *	0.027	10	15 **	TRS	
3 NITROGEN OXIDES	0.01	0.25 ***	N/A	-	-	NO_x	OXIDES of NITROGEN
4 NITROGEN DIOXIDE	0.01	N/A	0.20	5	5	NO_2	
5 NITRIC OXIDE	0.01	N/A	N/A	25	35	NO	NITROGEN MONOXIDE
6 OZONE	0.01	0.1	0.08	0.1	0.3	O_3	
7 CARBON MONOXIDE	0.1	5.0	30.0	50	400	CO	

* As equivalent H_2S and applicable only for Kraft Pulp Mills
TRS may contain any of the following: Hydrogen Sulphide (H_2S), Methyl Mercaptan (CH_3SH), Dimethyl Sulphide (C_2H_6S) and Dimethyl Disulphide ($C_2H_6S_2$) and others.

** The TWA and STEL for TRS as expressed solely as Hydrogen Sulphide concentrations

*** Expressed as NO_2

Table #3

Niagara '87 Air Quality Survey

Monitoring Periods and Site Information - MAMu#1

Monitoring Period *	Start Monitoring (hr/dd/mm)	Duration (hrs)	End Monitoring (hr/dd/mm)	Site ** Location	# GC Runs	Comments
A151	12:48/15/06	3.7	16:28/15/06	TR	3	In Mist
A152	17:25/15/06	15.3	08:40/16/06	@2nd Intake	1	Overnight
A162	10:15/16/06	2.2	12:24/16/06	TR	2	In Mist
A165	16:03/16/06	17.3	09:23/17/06	@2nd Intake	1	Overnight
A172	10:52/17/06	1.3	11:10/17/06	TR	-	In Mist
A173	12:27/17/06	4.5	16:55/17/06	TR	3	In Mist
A174	17:17/17/07	15.0	08:17/18/07	@2nd Intake	-	Overnight
A181	09:06/18/07	0.9	10:02/18/07	NSRC	1	Upwind
A183	11:45/18/07	3.1	14:50/18/07	TR	2	In Mist
A185	15:57/18/07	16.8	08:42/19/07	@2nd Intake	-	Overnight
A191	09:19/19/07	3.1	12:25/19/07	TR	2	In Mist

* In the designation of Monitoring Periods: `A' refers to Mobile Air Monitoring Unit #1 (MAMu#1); the next two digits, the day of the month; the final digit, the data acquisition episode of the day.

** TR refers to Table Rock; a semi-permanent monitoring site located at the brink of Horseshoe Falls.

@2nd Intake refers to Water Intake Station #2 for Ontario Hydro; an overnight monitoring site located 2.5 km upstream and southeast of Horseshoe Falls.

NSRC refers to Niagara South Recreation Centre (Chippawa).

Table #4

Common Contaminants - Niagara '87 Air Quality Survey

Overall Average Ground Level Concentrations (ppm)

Monitoring Period	Start Time	Duration (hrs)	CO	THC	SO2	NO2	O3	Average Wind *
A151	15/12:47	3.7	0.81	2.19	nd.	0.01	0.04	1205
A152	15/17:25	15.3	1.07	na.	nd.	0.02	0.02	****
A162	16/10:15	2.2	0.51	1.58	nd.	0.02	0.03	2509
A165	16/16:03	17.3	0.45	na.	nd.	0.01	0.03	****
A172	17/10:52	1.3	1.86	1.65	nd.	0.02	0.03	1008
A173	17/12:27	4.5	0.22	1.48	nd.	0.01	0.03	1407
A174	17/17:17	15.0	0.49	1.20	nd.	0.03	0.02	****
A181	18/09:06	0.9	0.73	1.37	nd.	0.03	0.02	0005
A183	18/11:45	3.1	0.54	1.62	nd.	0.02	0.05	1412
A185	18/15:57	16.8	0.59	na.	nd.	0.03	0.03	****
A191	19/09:19	3.1	0.61	2.26	nd.	0.03	0.05	2503

Maximum One-Hour Average Ground Level Concentrations (ppm)

Monitoring Period	CO	THC	SO2	NO2	O3	Wind at time of Maximum *
A151	0.90	2.41	nd.	0.01	0.04	1205
A152	1.75	2.05	nd.	0.04	0.06	3420
A162	0.67	1.64	nd.	0.02	0.03	2509
A165	0.82	na.	nd.	0.03	0.05	1220
A172	1.99	1.67	nd.	0.02	0.03	1008
A173	0.31	1.59	nd.	0.02	0.03	3004
A174	1.25	1.61	nd.	0.06	0.04	1204
A183	0.57	1.82	nd.	0.02	0.06	1412
A185	1.00	na.	nd.	0.05	0.05	calm
A191	0.71	2.36	nd.	0.03	0.06	2503

na. - not available; instrument malfunction, insufficient time, etc.

nd. - not detected; concentration in ambient air less than detection limit of analyzer. The detection limit for the SO2 analyzer was 0.01 ppm.

* - the first two digits refer to the direction (in tens of degrees)from which the wind was blowing and the last two digits refer to the speed in km/hr.

**** - overnight monitoring; average wind not applicable

Monitoring Period - the 'A' refers to Mobile Air Monitoring Unit #1; the next two digits, the day of the month; and the last digit, the monitoring episode of the day.

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	Average	Maximum
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
1 PROPANE		0.8	1.2	1.0	0.9	4.1	3.8	1.2	1.8	1.0	0.7	3.4	3.0	3.0	10.2	6.8	2.9	10.2
2 PROPADIENE																		
3 PROPYNE																		
4 CHLOROMETHANE																		
5 CYCLOPROPANE																		
6 2-METHYLPROPANE		0.8	0.9	0.9	0.7	6.5	9.2	1.1	3.6	1.2	0.5	3.4	2.8	2.9	6.6	3.8	3.0	9.2
7 CHLOROETHENE																		
8 2-CHLORO-2METHYLPROPANE																		
9 1-BUTENE		0.8	0.9	0.8		0.7	1.0	1.9	1.1			0.9	0.5	0.2	1.7	0.7	0.9	1.9
10 1,3-BUTADIENE																		
11 BUTANE		2.7	3.1	3.2	2.3	13.4	17.6	3.4	15.0	3.8	1.7	11.7	8.9	8.5	19.5	9.5	8.3	19.5
12 1-BUTYNE																		
13 CHLOROETHANE																		
14 3-METHYL-1-BUTENE																		
15 2-METHYLBUTANE		2.3	3.4	2.6	1.9	6.5	7.7	5.1	13.6	3.3	1.2	9.6	6.6	6.1	15.3	7.5	6.2	15.3
16 2-METHYL-1-BUTENE			0.4			0.5	0.7	0.8	1.8	0.4		0.7			1.4	0.6	0.8	1.8
17 PENTANE		1.9	2.6	2.3	1.4	4.6	5.1	4.1	10.3	2.3	0.9	6.5	3.9	3.5	11.1	5.5	4.4	11.1
18 2-METHYL-1,3-BUTADIENE		0.7	1.0	1.0		2.0	2.1	1.5	0.9	0.6	0.6	1.4	0.9		3.5	2.1	1.4	3.5
19 trans-2-PENTENE			0.4	0.4		0.6	0.7	1.1	2.6	0.4		1.0			2.1	0.7	1.0	2.6
20 cis-2-PENTENE																		
21 DICHLOROMETHANE																		
22 2-METHYL-2-BUTENE		0.3	0.5	0.6		0.6	0.7	1.4	2.8	0.6	0.2	1.3	0.5		2.2	0.9	1.0	2.8
23 2,2-DIMETHYLBUTANE							0.3	0.3	0.7			0.4	0.3	0.3	0.7	0.3	0.4	0.7
24 trans-1,2-DICHLOROETHENE																		
25 3-METHYL-1-PENTENE																		
26 4-METHYL-1-PENTENE																		

16/07/87

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	Average	Maximum
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
27 CYCLOPENTANE			0.2	0.2			0.6	0.4	1.1	0.3		1.0	0.7	0.3	1.0	0.6	0.6	1.1
28 2,3-DIMETHYLBUTANE			0.2	0.6				0.6	1.3	0.3	0.2		0.5	0.4	1.2	0.6	0.6	1.3
29 2-METHYLPENTANE			1.4	1.5	0.9	2.7	2.1	3.2	7.3	1.5	0.5	4.1	2.3	1.9	6.5	3.2	2.8	7.3
30 3-METHYLPENTANE		0.8	1.0	0.9				2.2	4.9	0.9	0.7		1.4	1.1	4.8	1.9	1.9	4.9
31 1-HEXENE			0.4					0.4	0.3								0.3	0.4
32 cis-1,2-DICHLOROETHENE												1.5					1.5	1.5
33 2-CHLOROBUTANE									1.3								1.3	1.3
34 1-CHLORO-2-METHYLPROPANE																		
35 HEXANE		1.4	1.3	1.5	0.8	2.4	1.9	2.7	6.0	1.2	0.5		1.9	1.5	5.4	2.7	2.2	6.0
36 CHLOROFORM																		
37 trans-3-HEXENE								0.2	0.3								0.3	0.3
38 3-CHLORO-2-METHYLPROPENE																		
39 METHYLCYCLOPENTANE			0.4	0.4	0.2	0.7	0.6	1.1	2.0	0.4	0.2	1.2	0.7	0.6	1.7	0.9	0.8	2.0
40 2,4-DIMETHYLPENTANE												0.4			0.5	0.3	0.4	0.5
41 1,2-DICHLOROETHANE																		
42 2,2-DIMETHYLPENTANE								0.2	0.5								0.4	0.5
43 2,2,3-TRIMETHYLBUTANE																		
44 1,1,1-TRICHLOROETHANE																		
45 1-CHLOROBUTANE																		
46 BENZENE		2.3	2.9	2.7	1.1	2.6	2.1	4.3	3.3	1.9	0.8	5.5	3.6	3.3	4.2	2.9	2.9	5.5
47 TETRACHLOROMETHANE																		
48 3,3-DIMETHYLPENTANE																		
49 CYCLOHEXANE								0.3	0.4						0.3	0.2	0.3	0.4
50 2,3-DIMETHYLPENTANE								1.6	2.7		0.2				0.1		1.2	2.7
51 2-METHYLHEXANE		0.6	0.6	0.7	0.4	1.1	1.2	1.6	2.7	0.6	0.2	1.6	1.0	0.9	2.6	1.2	1.1	2.7
52 CYCLOHEXENE																		

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	**Average**	**Maximum**
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
53 DIBROMOMETHANE																		
54 1,2-DICHLOROPROPANE																		
55 3-METHYLHEXANE		0.4	0.4	0.4	0.2	0.7	0.6	1.0	1.9	0.4	0.2	1.1	0.6	0.5	1.8	0.9	0.7	1.9
56 2,3-DICHLOROPROPENE																		
57 TRICHLOROETHENE																		
58 2,2,4-TRIMETHYLPENTANE		0.2	0.3	0.3		0.4	0.4	0.4	0.7	0.2	0.1	0.8	1.0	0.6	0.8	0.8	0.5	1.0
59 1-HEPTENE																		
60 HEPTANE		0.4	0.4	0.4		0.7	0.6	0.5	1.4	0.3	0.2	1.0	0.6	0.5	1.5	0.9	0.7	1.5
61 trans-2-HEPTENE																		
62 METHYLCYCLOHEXANE						0.3	0.2	0.4	0.6			0.4	0.3	0.2	0.9	0.5	0.4	0.9
63 2,2-DIMETHYLHEXANE																		
64 ETHYLCYCLOPENTANE																		
65 4-METHYLCYCLOHEXENE																		
66 2,5-DIMETHYLHEXANE															0.6		0.6	0.6
67 1-CHLOROPENTANE																		
68 1,1,2-TRICHLOROETHANE																		
69 2,3,4-TRIMETHYLPENTANE									0.3			0.3	0.2		0.3		0.2	0.3
70 TOLUENE		3.1	3.7	3.7	1.8	3.7	3.1	6.2	4.8	2.0	1.3	5.7	4.3	3.7	8.0	4.8	4.0	8.0
71 1,3-DICHLOROPROPANE																		
72 2-METHYLHEPTANE			0.1			0.3	0.3	0.4	0.5			0.4					0.3	0.5
73 4-METHYLHEPTANE		0.1							0.2			0.2		0.1	0.5	0.3	0.2	0.5
74 c-1,3-DIMETHYLCYCLOHEXANE		0.1	0.0			0.2		0.2	0.3			0.4	0.2				0.2	0.4
75 3-METHYLHEPTANE		0.2	0.0	0.2		0.5	0.3	0.7	0.8	0.2	0.1	0.6	0.3				0.3	0.8
76 1,2-DIBROMOETHANE																		
77 1,1-DIMETHYLCYCLOHEXANE																		
78 1-OCTENE																		

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	Average	Maximum
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
79 trans12DIMETHYLCYCLOHEXAN																		
80 trans-4-OCTENE																		
81 TETRACHLOROETHENE												2.0	2.5	1.8			2.1	2.5
82 c-1,4-DIMETHYLCYCLOHEXANE																		
83 OCTANE		0.3	0.3			0.5	0.3	0.4	0.5			0.6	0.3	0.2	0.6	0.6	0.4	0.6
84 trans-2-OCTENE																		
85 cis12DIMETHYLCYCLOHEXANE																		
86 CHLOROBENZENE																		
87 ETHYLCYCLOHEXANE																0.1	0.1	0.1
88 1-CHLOROHEXANE																		
89 ETHYLBENZENE		0.5	0.5	0.5	0.3	0.9	0.5	1.1	0.9	0.4	0.2	1.2	0.9	0.6	1.9	0.9	0.8	1.9
90 m- and p- XYLENES		1.4	1.4	1.5	0.7	2.6	1.3	3.6	2.7	1.2	0.7	3.4	1.8	1.4	5.3	2.3	2.1	5.3
91																		
92 4-METHYLOCTANE								0.2				0.3					0.3	0.3
93 2-METHYLOCTANE																		
94 3-METHYLOCTANE						0.1			0.2			0.3			0.7	0.3	0.3	0.7
95 STYRENE								0.5									0.5	0.5
96 1,4-DICHLOROBUTANE																		
97 o-XYLENE		0.5	0.5	0.5	0.2	1.0	0.5	1.4	1.1	0.4	0.2	1.2	0.7	0.5	2.2	0.9	0.8	2.2
98 1,1,2,2-TETRACHLOROETHANE																		
99 1,2,3-TRICHLOROPROPANE																		
100 1-NONENE																		
101 trans-1,4-DICL-2-BUTENE																		
102 NONANE		0.6	0.4	0.2		0.3	0.2	0.2	0.3		0.1	0.7		0.2	0.6	1.1	0.4	1.1
103 ISOPROPYLBENZENE																		
104 2-CHLOROTOLUENE											0.1	0.3				0.4	0.3	0.4

16/07/87

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	Average	Maximum
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
105 3-CHLOROTOLUENE																		
106 4-CHLOROTOLUENE			0.4									0.6			0.4		0.5	0.6
107 PROPYLBENZENE						0.3		0.4	0.3			0.3			0.6		0.4	0.6
108 3-ETHYLTOLUENE		0.4	0.6	0.5		1.0	0.4	1.4	0.9	0.5	0.3	0.9		0.5	2.3	1.2	0.8	2.3
109 4-ETHYLTOLUENE						0.8		0.9				0.6			1.5		0.9	1.5
110 1,3,5-TRIMETHYLBENZENE		0.5	0.5	0.3		0.7	0.3	1.2	0.7	0.3	0.2	0.8			1.6	0.9	0.7	1.6
111 2-ETHYLTOLUENE						0.4		0.6	0.3			0.3			0.9	0.3	0.5	0.9
112 1,2,4-TRIMETHYLBENZENE		1.2	1.1	1.0		1.9	0.8	4.5	1.9	0.8	0.5	1.6	0.9	0.6	4.4	1.9	1.6	4.5
113 tert.BUTYLBENZENE		0.7	0.7	0.6		1.1	0.5	2.7	1.2	0.5	0.3	0.9	0.5	0.4	3.3	1.2	1.0	3.3
114 tert.BUTYLCYCLOHEXANE																		
115 1,3-DICHLOROBENZENE																		
116 1-DECENE																		
117 (CHLOROMETHYL)BENZENE																		
118 1,5-DICHLOROPENTANE																		
119 isoBUTYLBENZENE																		
120 DECANE		1.1	1.1	0.6	0.2		0.6		0.8	0.3	0.2	0.8		0.3		1.5	0.7	1.5
121 sec.BUTYLBENZENE																		
122 3-(CHLOROMETHYL)HEPTANE																		
123 1,2,3-TRIMETHYLBENZENE		0.4	0.5	0.4		0.6		1.3	0.6		0.2	0.6			1.5	0.8	0.7	1.5
124 1ISOPROPYL4METHYLBENZENE																0.5	0.5	0.5
125 1,2-DICHLOROBENZENE																		
126 INDAN								1.1							0.8		0.9	1.1
127 BUTYLCYCLOHEXANE																		
128 1,3-DIETHYLBENZENE																		
129 1,4-DIETHYLBENZENE																		
130 BUTYLBENZENE								0.4	0.3								0.3	0.4

TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	**Average**	**Maximum**
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
131 1,2-DIETHYLBENZENE																		
132 transDECAHYDRONAPHTHALENE																		
133 cis-DECAHYDRONAPHTHALENE																		
134 UNDECANE			1.9		0.5			1.2							0.8		1.1	1.9
135 1235-TETRAMETHYLBENZENE								0.8									0.8	0.8
136 1234-TETRAMETHYLBENZENE								0.7									0.7	0.7
137 1,3-DIISOPROPYLBENZENE																		
138 1234TETRAHYDRONAPHTHALENE																		
139 1,4-DIISOPROPYLBENZENE																		
140 NAPHTHALENE																		
141 DODECANE					0.9			2.1									1.5	2.1

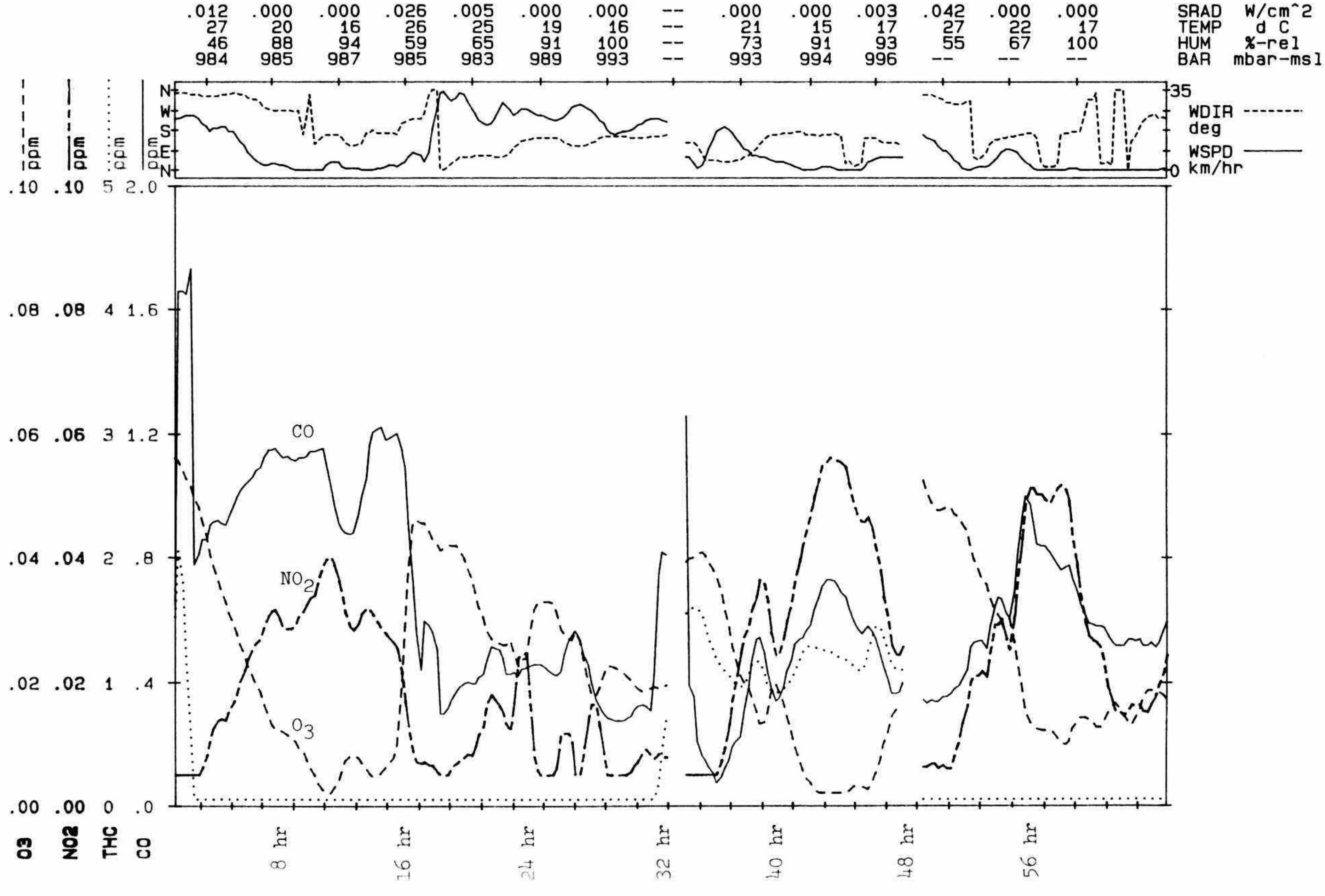
TABLE 5

Niagara Falls '87 Volatile Organic Compounds - Gas Chromatograph Analysis

Monitoring Period		A151	A151	A151	A152	A162	A162	A165	A173	A173	A173	A181	A183	A183	A191	A191		
		JUNE 15	JUNE 15	JUNE 15	JUNE 15	JUNE 16	JUNE 16	JUNE 17	JUNE 17	JUNE 17	JUNE 17	JUN 18	JUNE 18	JUNE 18	JUNE 19	JUNE 19		
Sampling Times	Start	12:55	13:55	14:55	16:56	9:52	10:52	8:12	12:20	13:20	15:19	9:10	11:59	12:59	9:06	10:06	Average	Maximum
	End	13:55	14:55	15:55	17:56	10:52	11:52	9:12	13:20	14:20	16:19	10:10	12:59	13:59	10:06	11:06		
Total Compounds Identified		31	40	35	20	38	35	56	51	31	31	48	32	33	49	45	38.3	56.0
Total # of Peaks		54	52	51	29	57	54	82	97	42	43	70	71	42	100	73	61.1	100.0
Total Area of Peaks		1758	1848	1754	1023	2830	2815	3403	4715	1244	1302	3515	2533	1875	6353	3225	2679.4	6352.6
Area of Identified Peaks		1157	1383	1376	711	2355	2313	2723	3727	1051	946	2726	1883	1663	5174	2588	2118.4	5174.1
Area % Identified Peaks		66	75	78	70	83	82	80	79	84	73	78	74	89	81	80	78.2	88.7
Total Hydrocarbons (ug/m3)		27.7	37.4	32.4	15.5	68.0	68.3	76.6	112.0	28.0	13.8	83.7	54.6	46.3	146.2	75.7	59.1	146.2
Alkanes (ug/m3)		14.7	20.7	17.3	11.1	44.6	52.2	34.0	77.3	17.4	8.1	47.9	35.4	32.2	92.6	49.5	37.0	92.6
Cycloalkanes (ug/m3)		0.1	0.7	0.7	0.2	1.3	1.3	2.3	4.4	0.7	0.2	3.0	2.0	1.1	3.9	2.3	1.6	4.4
Alkenes (ug/m3)		1.8	3.4	2.8	0.0	4.4	5.2	7.2	9.7	2.0	0.8	5.4	1.9	0.2	10.9	5.0	4.1	10.9
Cycloalkenes (ug/m3)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkynes (ug/m3)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aromatics (ug/m3)		11.1	12.3	11.6	4.2	17.8	9.6	32.9	18.9	8.0	4.7	23.0	12.7	11.0	38.5	18.5	15.6	38.5
Chlorinated Alkanes (ug/m3)		0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.8
Chlorinated Alkenes (ug/m3)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	2.5	1.8	0.0	0.0	0.5	3.5
Chlorinated Aromatics (ug/m		0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	0.0	0.0	0.4	0.4	0.1	0.9
Benzene:Ethylbenzene		4.6	5.5	5.6	3.9	2.8	4.1	4.0	3.6	4.8	3.4	4.5	4.1	5.1	2.2	3.4	4.1	5.6
Toulene:Etylbenzene		6.2	7.1	7.5	6.2	4.0	6.2	5.9	5.3	5.1	5.2	4.7	4.9	5.8	4.2	5.7	5.6	7.5
Xyzlene:Ethylbenzene		3.8	3.7	4.0	3.2	3.9	3.5	4.7	4.1	4.0	4.1	3.8	2.9	3.0	3.9	3.7	3.7	4.7

NIAGARA_FALLS_87: M001

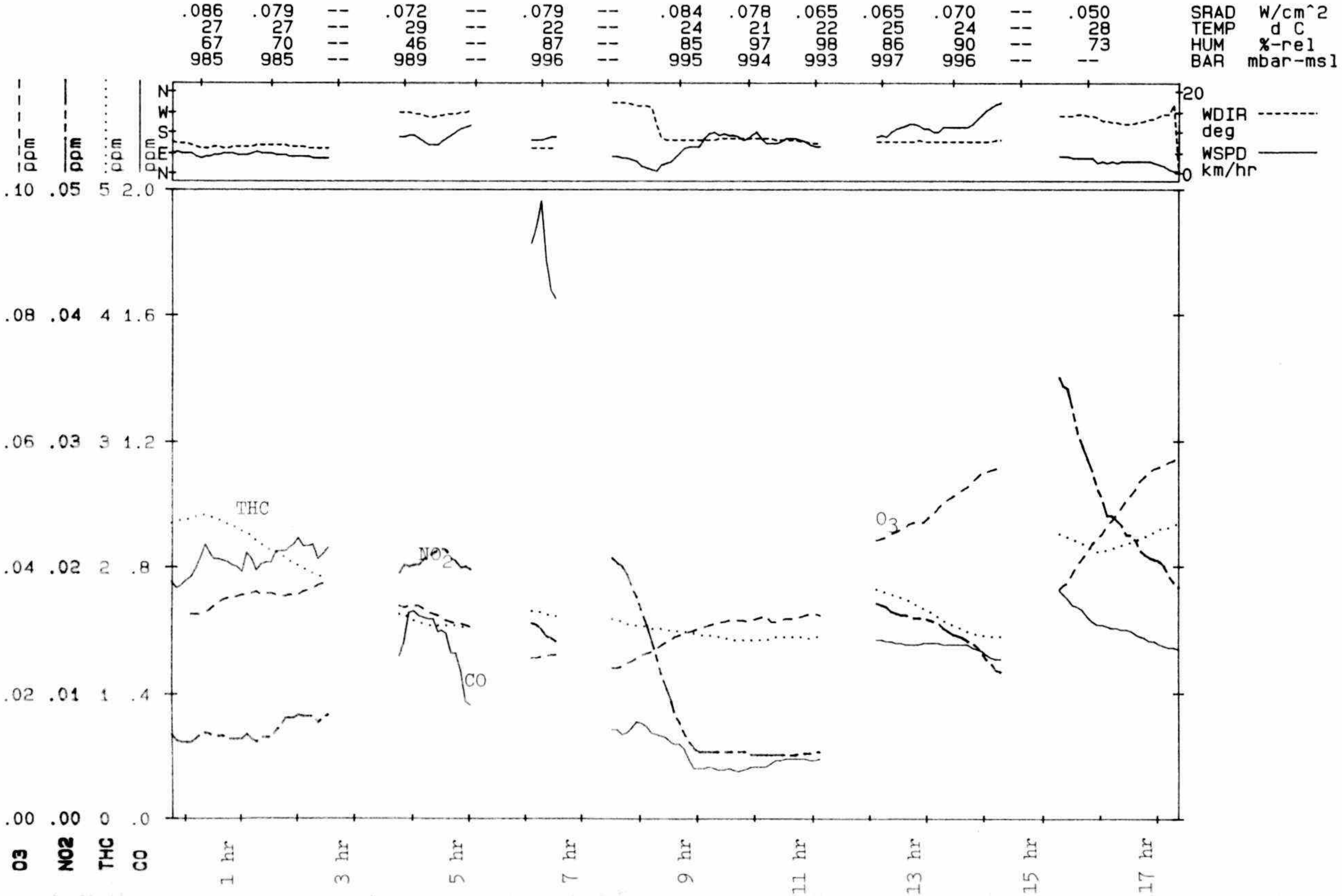
Start: 87/06/15 17:20 Scan: 300 sec. Ave: 60.00 min.
Loc: Merging of all Data acquired overnight @ 2nd Intake



Graph 1

NIAGARA_FALLS_87: F001

Start: 87/06/15 12: 47 Scan: 60 sec. Ave: 60.00 min.
Loc: All data acquired at the Brink & in the Mist of Horseshoe Falls



Graph 2

Appendix B ... TAGA Methodology for PCB Monitoring

TAGA METHODOLOGY

In 1979 the Air Resources Branch of the Ontario Ministry of the Environment acquired a mobile Trace Atmospheric Gas Analyzer (TAGA) from Sciex Incorporated of Thornhill, Ontario. The mobile TAGA unit (MAMU No. 3) has been applied to a variety of air monitoring situations, including airborne PCBs. The Ministry has conducted over 50 air quality surveys with the mobile TAGA unit.

The TAGA 3000 is simply a specialized quadrupole mass spectrometer coupled to a unique sampling inlet and ion source (See Figure A1). Ionization of pollutants is achieved through chemical ionization, initiated by a stable corona discharge operating at atmospheric pressure. Since the ion source permits continuous, direct, air sampling at a high flow rate (100 l/min), it is possible to determine the temporal and spatial distribution of selected pollutant levels. The mobile TAGA's capabilities are especially suitable for plume tracking; that is, tracing a pollutant back to its source of origin.

When equipped with the standard atmospheric-pressure chemical ionization (APCI) source the TAGA system is sensitive to most volatile compounds containing a heteroatom, such as N,O,S,P and halide. Typical detection limits are in the range of 0.1 to 10 ug/m3 depending on the type of chemical measured and the sample matrix.

The mobile TAGA unit is also equipped with a 10 metre, telescopic tower and meteorological instrumentation to measure local wind speed, wind direction and ambient temperature. All meteorological data are stored by the on-board computer simultaneously with the collection of air quality data. The data are instantly displayed on the CRT unit allowing the operator to assess the data on-site and thus formulate the appropriate survey strategy.

PCB MONITORING METHODOLOGY

For most chemical classes the sensitivity of the TAGA is extraordinary for ambient air monitoring. However PCBs are an exception, because the absolute sensitivity is insufficient for instantaneous real-time detection. Thus in the late 1970's Sciex Inc. developed a simple sampling device to preconcentrate volatile PCBs. Preconcentrating the PCBs for only 2-minutes improves the detection limit by two orders of magnitude.

Although the basic principles have remained unchanged, today's PCB preconcentrator has evolved into a portable sampling inlet system with all operating parameters under strict computer control. It is commercially known as the Automated Short Term Adsorber or ASTA.

The ASTA, shown in Figure A2, consists of two sample probes formed by coiling a nichrome wire, coated with a gas chromatographic stationary phase, OV-17. The positions, and thus functions of the two probes, are interchangeable between the adsorption or sampling position, and the desorption or analysis position. While one probe is adsorbing PCBs from the ambient air, the other probe is being desorbed and analysed for PCBs from a previous air sample. Altering the positions of the two probes permits continuous screening of the ambient air in 2 minute intervals. There is approximately an eight second delay between sampling periods due to the probe cycling time. Thus a "1/2-hour sample", which consists of 15 consecutive 2 minute samples, takes 32 minutes to obtain.

Sampling

When sampling for PCBs the probe is placed directly in the ambient air stream (1.7 l/s) for a period of 2 minutes. The probe is then changed to the desorb position and 12 volts DC potential (3.25 amperes) is applied to the probe for a period of 40 seconds. This causes the probe temperature to rapidly increase to approximately 300 °C, thereby transferring the PCBs from the OV-17 into the gas phase. The carrier gas, which is a mixture of ultra pure zero air and benzene (100 ppm), constantly sweeps the PCBs into the ion source. Upon entering the ion source the PCBs immediately undergo benzene chemical ionization, producing molecular PCB ions (M+) which are (mass) selectively monitored by the quadrupole mass filter.

The software allows for the screening of 4 PCB congeners at 8 masses, 2 isotopes per congener. Normally the dichlorobiphenyl to pentachlorobiphenyl species are monitored. There are several reasons for this: firstly, the TAGA is more sensitive to these species. Secondly, PCBs with lower molecular weights generally exhibit higher vapour pressures, thus increasing the likelihood of gas phase detection; and, thirdly, in previous PCB surveys the higher molecular weight PCBs were rarely detected when the lower molecular weight PCBs were not observed.

Calibration

Calibration of the system, including sampling probe adsorption efficiencies and TAGA response, is accomplished by continuously injecting known amounts of PCBs directly into the air sampling stream. The PCBs are injected via a heated injection port (300 °C) using a gas-tight syringe and motorized syringe drive. The PCB standards are prepared by the dissolution of pure PCB isomers, one per congener, into iso-octane. Repeated injections at 5 different syringe drive settings establish a calibration curve which is linear (correlation coefficients are usually better than 0.995) over the PCB concentration range of 0.425 to 2.5 ug/m^3 per congener (See Figure A3). The relative standard deviations for multiple injections of PCB standards are typically better than 15% at the 0.425 ug/m3 level.

DATA PROCESSING AND INTERPRETATION

Immediately following a desorption of the probe, the TAGA computer calculates the level of PCBs (or equivalents) per congener, per isotope, from the net signal (sample minus background) and the daily calibration factors. In fact, for each PCB congener group, two measurements are made: one for the chlorine 35 isotope (M), and one for the corresponding chlorine 37 isotope (M+2).

Criteria

At this stage the field survey scientist interprets the reduced data using the following criteria:

1) the adsorption peak (integrated signal) must be as least 3 times greater than the probe noise (S/N>3);

2) the PCB levels for a given isotope pair must be within the overall experimental accuracy of 20%;

3) the calculated isotope ratios must be within 10% of the theoretical isotope ratio for a given congener.

If condition 1) above is not satisfied, the congener concentration will be considered below the detection limit and a ND is reported. If conditions 2) and 3) are not evident then a chemical interference at one, or both, of the congener masses is assumed to be present, and the lower concentration value of the two isotopes is assigned the upper concentration limit for that particular PCB congener. The value is then flagged with the letter "i" indicating that a chemical interference has inflated the reported concentration. An example of a data print-out showing the PCB desorption curves may be seen in Figure A4.

Detection Limit

The PCB detection limit for the TAGA/ASTA technique is defined as being 3 times the standard deviation of the background signal observed at the PCB masses, divided by the appropriate calibration factors. Thus by definition, the detection limit depends on two important factors:

i) the sensitivity, which is a function of the probe adsorption efficiencies and the benzene chemical ionization rates.

ii) the level of the interferences (adsorbed compounds that have the same nominal ionic mass as the targeted PCBs in both upwind and downwind air samples). Interference levels are highly variable depending on the sampling site, the source(s) in the immediate area, and the local meteorological conditions.

During a survey air samples are spiked periodically with 0.425 ug/m3 per PCB congener to establish the daily sensitivity factors and determine, on-site, the detection limits of the technique. Typical detection limits range from 0.01 to 0.05 ug/m3 per congener, or from 0.04 to 0.20 ug/m3 for total (di to pentachlorobiphenyls) PCBs, depending on the complexity of the sample matrix.

SUMMARY

The TAGA/ASTA PCB monitoring technique is a specialized application of the mobile TAGA 3000. It was developed to rapidly screen the ambient air for volatile PCBs. Important features of the technique to consider when assessing the data are:

1) The technique was developed to measure gas phase PCBs. (Should non-volatile PCBs be trapped by the probe they would be reported as volatile PCBs and included in the total amounts.)

2) PCB levels are determined continuously every 2 minutes.

3) Four congeners are monitored simultaneously (normally the dichlorobiphenyls to pentachlorobiphenyls).

4) The detection limits for total PCBs typically range from 0.04 to 0.20 ug/m3 depending on the sample matrix.

In summation, the mobile TAGA/ASTA technique is a rapid screening method for volatile PCBs, providing near real-time detection at the time when PCBs are potentially released into the atmosphere. It is the only method currently available to the Ministry by which the ambient air can be instantaneously scanned for PCBs, providing valuable information, on-site.

TAGA 3000 SYSTEM

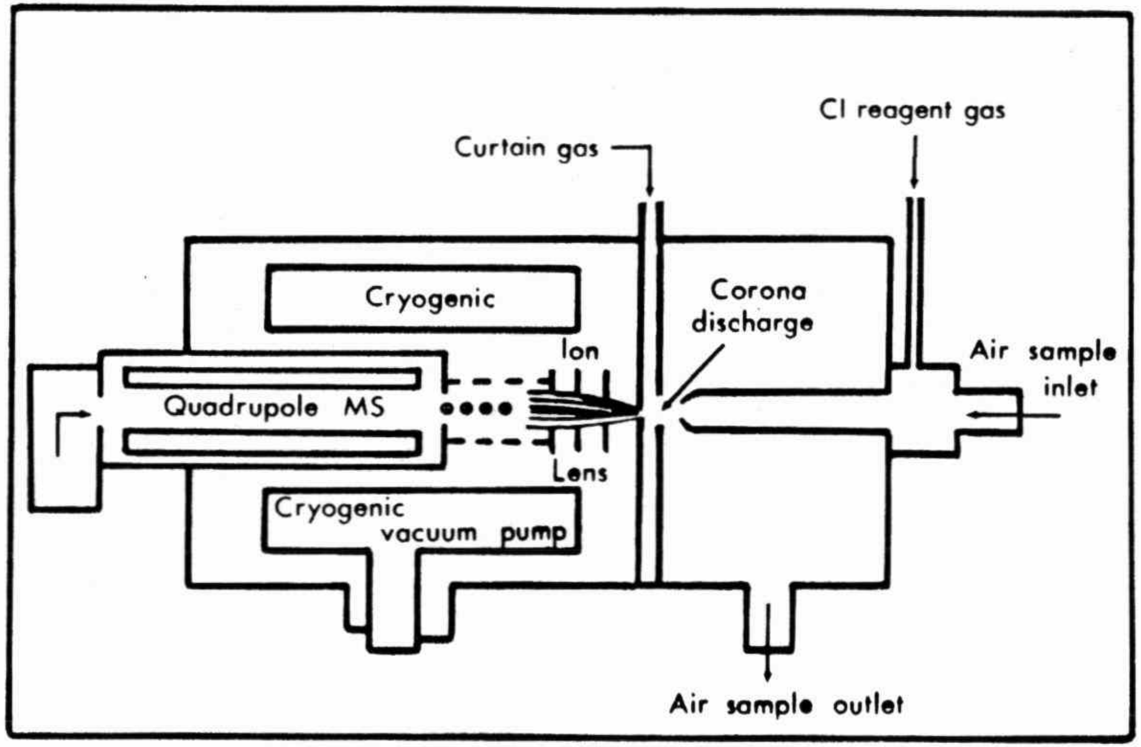


FIGURE A1: SCHEMATIC OF THE TAGA 3000 SYSTEM
INSTALLED IN MAMU #3

ASTA SCHEMATIC

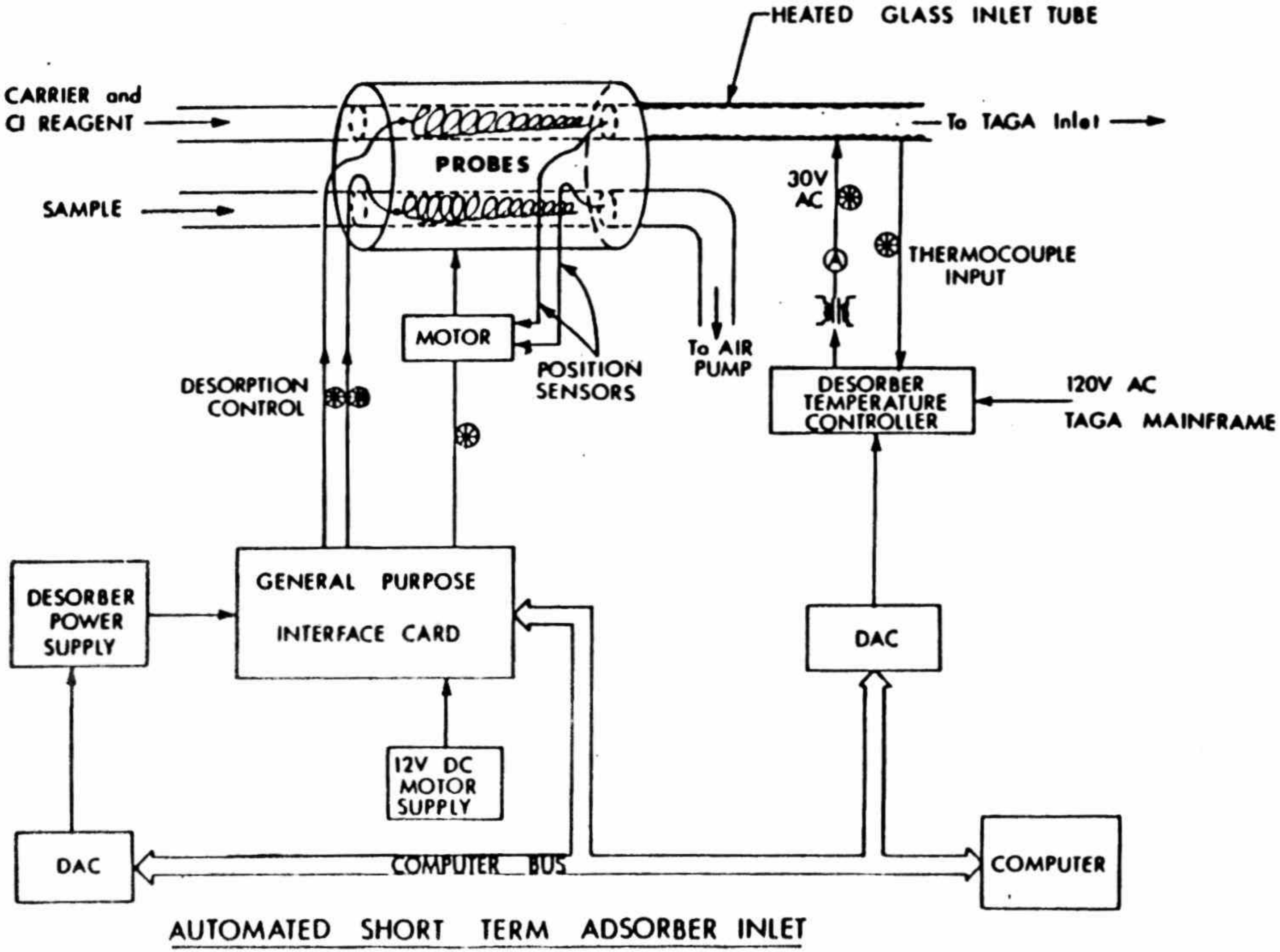


Figure A2: Schematic of the ASTA used in conjunction with the TAGA PCB Monitoring technique.

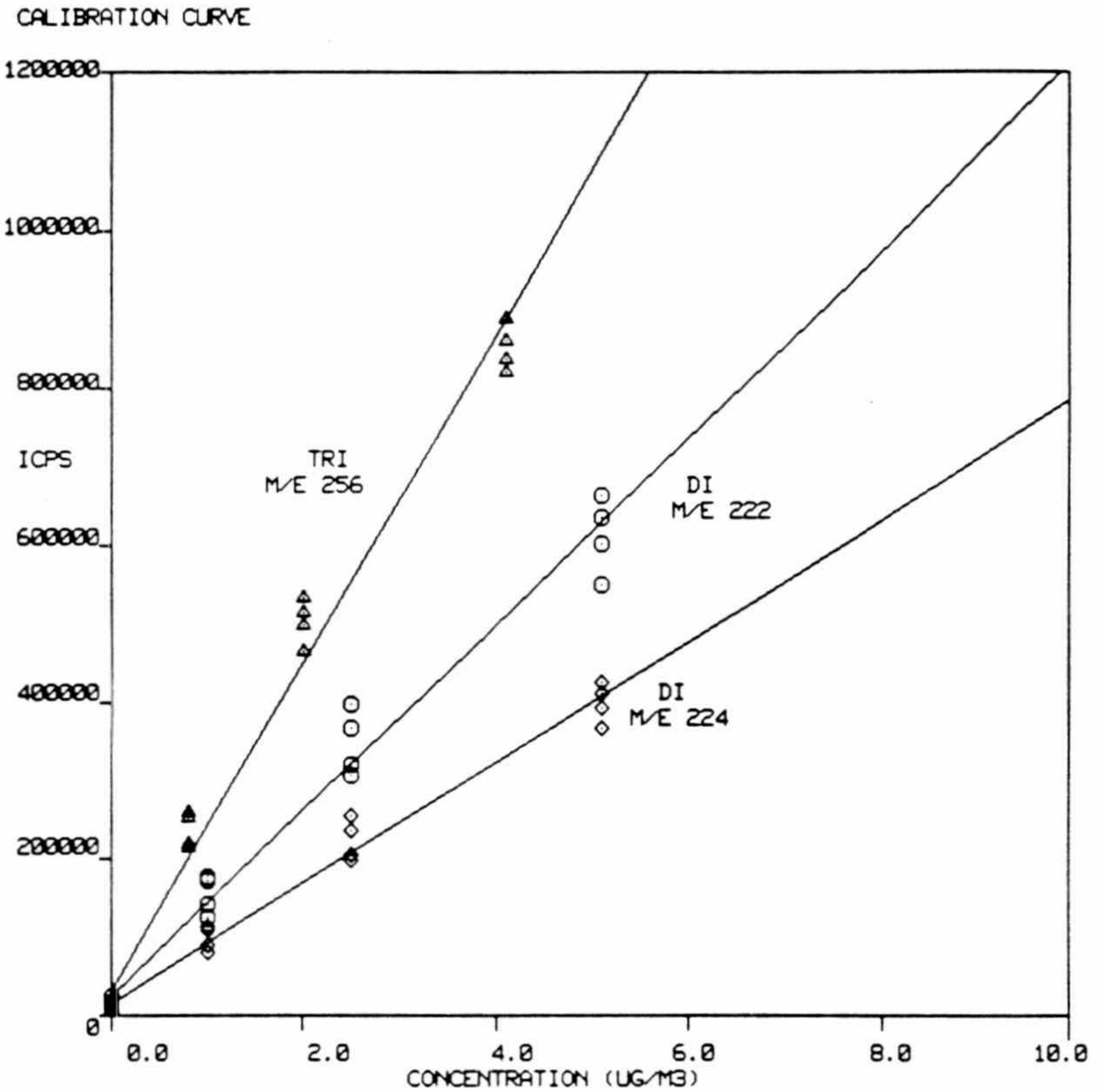
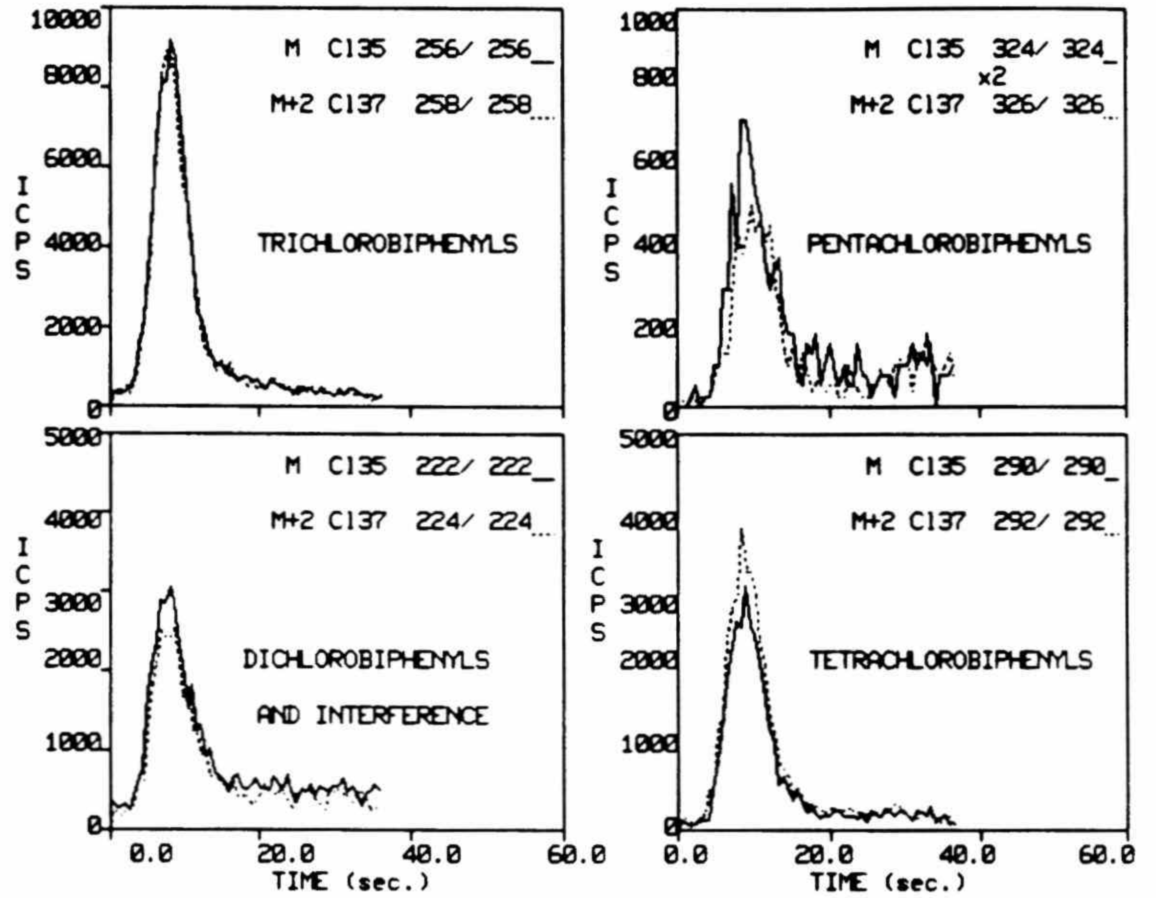


FIGURE A3: EXAMPLE OF CALIBRATION CURVE
FOR DI AND TRICHLOROBIPHENYLS

TAGA/ASTA MONITORING TECHNIQUE



```
MP/MD     MAX.INT TIM.MAX INT.IONS    NET       CONC    RATIO TO MP/MD      THEOR.
------    ------- ------- --------    ---       ----    --------------      ------
222/ 222    3053.    8.40   17143.   14691.     0.39i    1.283  224/ 224     1.540
224/ 224    2520.    9.12   13994.   11452.     0.47     0.780  222/ 222     0.650
256/ 256    9213.    8.56   46335.   43368.     0.60     1.056  258/ 258     1.030
258/ 258    8906.    8.64   43545.   41069.     0.62     0.947  256/ 256     0.975
290/ 290    3067.    9.36   14284.   12730.     0.23     0.818  292/ 292     0.769
292/ 292    3800.    8.80   17271.   15562.     0.23     1.222  290/ 290     1.300
324/ 324     360.    9.52    1707.    1303.     0.10     0.620  326/ 326     0.615
326/ 326     507.   10.24    2662.    2099.     0.11     1.612  324/ 324     1.626
                                                ----
                                                1.3i
```

FIGURE A4: Example of TAGA data print-out, PCB analysis. Concentrations are in units of ug/m3. Note the ratio for isotope (222/224) dichlorobiphenyl is mismatched. Total PCB level is computed to be 1.3i ug/m3, where i denotes a contribution by interference at masses 222 and/or 224.

Appendix C ... MAMU#3 and the PCB Results

Map #1 --- Monitoring Locations for MAMU#3 (TAGA)

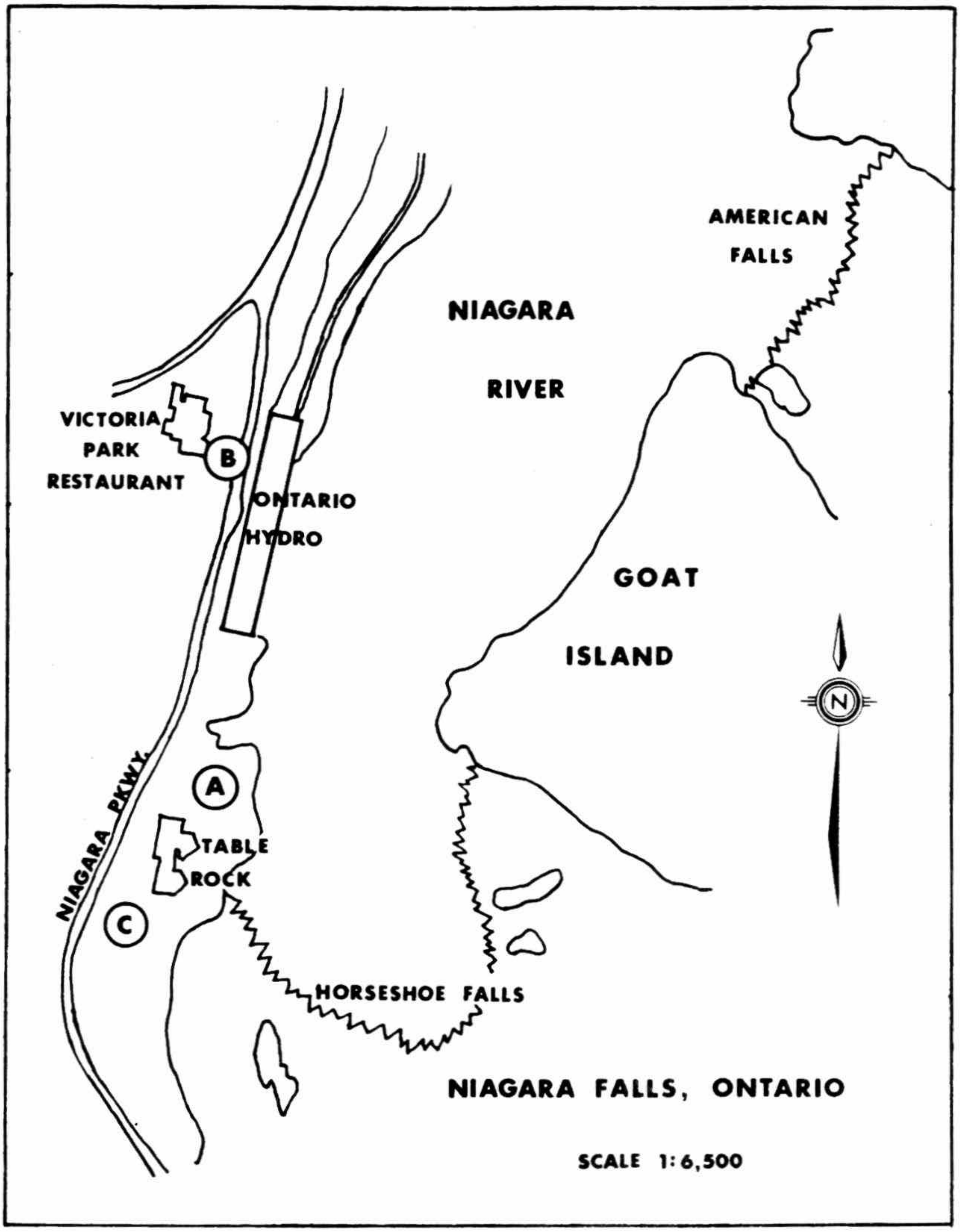


Table 1: PCB Results (TAGA) for June 15, 1987

Niagara Falls Survey

Sample[1] #	Site[2]	Time[3]	Meteorology[4] AT	WD	WS	Concentrations[5] (ug/m^3) (DL)	DI (.04)	TRI (.01)	TETRA (.02)	PENTA (.03)	Comments
1-1	A	14:53[3]	29	WNW	0-10		ND	.02i	ND	ND	Inter., light mist
1-2	A	15:25	29	WNW	0-10		ND	.03i	ND	ND	Inter., light mist

Notes: (1) All monitoring periods are 30 minutes (15x2-minute samples)
(2) See Figure 1 for monitoring locations
(3) Time refers to the start of the adsorb time of the first 2-minute sample
(4) AT = Ambient Temperature (°C); WD = Predominant Wind Direction; WS = Range of Wind Speed (km/hr)
(5) DL = Detection Limit (Based on the standard deviation of 15 2-minute background samples)
ND = Not Detected above the DL of the Di- to Pentachlorobiphenyl congeners;
i = Interference at the same nominal mass as PCB congener

Table 2: PCB Results (TAGA) for June 16, 1987

Niagara Falls Survey

Sample[1]	Site[2]	Time[3]	Meteorology[4]				Concentrations[5] (ug/m^3)				Comments
#			AT	WD	WS	(DL)	DI (.02)	TRI (.01)	TETRA (.02)	PENTA (.02)	
2-1	B	11:34	29	SSW	10-20		ND	ND	ND	ND	Intermittent mist
2-2	B	12:10	29	SSW	10-20		ND	ND	ND	ND	Intermittent mist
2-3	B	13:27	29	SSW	10-20		ND	.02i	ND	ND	In the mist
2-4	B	13:59	29	SSW	10-20		ND	ND	ND	ND	In the mist
2-5	B	14:34	29	SSW	5-20		.03i	.02i	ND	ND	In the mist
2-6	B	15:06	29	SSW	10-20		ND	ND	ND	ND	In the mist
2-7	B	16:11	27	SSW	10-20		ND	ND	ND	ND	In the mist

Notes: (1) All monitoring periods are 30 minutes (15x2-minute samples)
(2) See Figure 1 for monitoring locations
(3) Time refers to the start of the adsorb time of the first 2-minute sample
(4) AT = Ambient Temperature (°C); WD = Predominant Wind Direction; WS = Range of Wind Speed (km/hr)
(5) DL = Detection Limit (Based on the standard deviation of 15 2-minute background samples)
ND=Not De
i=Interfer

Table 3: PCB Results (TAGA) for June 17, 1987

Niagara Falls Survey

Sample[1]	Site[2]	Time[3]	Meteorology[4]			Concentrations[5] (ug/m^3)					Comments
#			AT	WD	WS		DI	TRI	TETRA	PENTA	
						(DL)	(.01)	(.02)	(.01)	(.02)	
3-1	C	09:19	21	E	5-20		ND	ND	ND	ND	In the mist
3-2	C	09:51	22	E	5-15		ND	ND	ND	ND	In the mist
3-3	C	10:26	23	E	5-20		.02i	ND	ND	ND	In the mist
3-4	C	10:58	23	ENE	5-20		ND	ND	ND	ND	In the mist
3-5	C	12:02	24	E	5-15		.02i	ND	ND	ND	In the mist
3-6	C	12:34	26	ENE	5-15		.02i	ND	ND	ND	In the mist
3-7	C	13:09	25	ENE	0-15		ND	ND	ND	ND	In the mist
3-8	C	13:41	25	E	5-15		ND	ND	ND	ND	In the mist

Notes: (1) All monitoring periods are 30 minutes (15x2-minute samples)
(2) See Figure 1 for monitoring locations
(3) Time refers to the start of the adsorb time of the first 2-minute sample
(4) AT = Ambient Temperature (°C); WD = Predominant Wind Direction; WS = Range of Wind Speed (km/hr)
(5) DL = Detection Limit (Based on the standard deviation of 15 2-minute background samples)
ND = Not Detected above the DL of the Di- to Pentachlorobiphenyl congeners;
i = Interference at the same nominal mass as PCB congener

Table 4: PCB Results (TAGA) for June 18, 1987

Niagara Falls Survey

Sample[1] #	Site[2]	Time[3]	Meteorology[4]				Concentrations[5] (ug/m^3)				Comments
			AT	WD	WS		DI	TRI	TETRA	PENTA	
						(DL)	(.04)	(.02)	(.03)	(.02)	
4-1	A	10:06	26	SE	5-10		ND	ND	ND	ND	Constant light mist
4-2	A	10:38	29	SE	0-10		ND	ND	ND	ND	Constant light mist
4-3	A	11:13	29	SE	0-5		ND	ND	ND	ND	Low winds
4-4	A	11:45	30	SE	0-5		ND	ND	ND	ND	Low winds
4-5	A	13:03	28	SE	0-10		ND	ND	ND	ND	Mist - light to nil
4-6	A	13:37	28	SE	0-10		ND	ND	ND	ND	Mist - light to nil
4-7	A	14:19	27	SSE	5-15		ND	ND	ND	ND	Mist - light to nil

Notes: (1) All monitoring periods are 30 minutes (15x2-minute samples)
(2) See Figure 1 for monitoring locations
(3) Time refers to the start of the adsorb time of the first 2-minute sample
(4) AT = Ambient Temperature (°C); WD = Predominant Wind Direction; WS = Range of Wind Speed (km/hr)
(5) DL = Detection Limit (Based on the standard deviation of 15 2-minute background samples)
ND = Not Detected above the DL of the Di- to Pentachlorobiphenyl congeners;
i = Interference at the same nominal mass as PCB congener

Table 5: PCB Results (TAGA) for June 19, 1987

Niagara Falls Survey

Sample[1] #	Site[2]	Time[3]	Meteorology[4]			Concentrations[5] (ug/m^3)					Comments
			AT	WD	WS		DI	TRI	TETRA	PENTA	
						(DL)	(.05)	(.03)	(.04)	(.04)	
5-1	B	11:47	29	SW	5-15		ND	ND	ND	ND	Inter., light mist
5-2	B	12:19	29	SW	5-15		ND	ND	ND	ND	Inter., light mist

Notes: (1) All monitoring periods are 30 minutes (15x2-minute samples)
(2) See Figure 1 for monitoring locations
(3) Time refers to the start of the adsorb time of the first 2-minute sample
(4) AT = Ambient Temperature (°C); WD = Predominant Wind Direction; WS = Range of Wind Speed (km/hr)
(5) DL = Detection Limit (Based on the standard deviation of 15 2-minute background samples)
ND = Not Detected above the DL of the Di- to Pentachlorobiphenyl congeners;
i = Interference at the same nominal mass as PCB congener

Appendix D ... Abbreviations

ABBREVIATIONS

APCI - Atmospheric pressure-chemical ionization
ASTA - Automated Short Term Adsorber
BTX(s) - benzenes, toluenes and xylenes
CC(s) - Common contaminant(s)
CH_4 - Methane
CO - Carbon monoxide
DL - Detection limit
GC - Gas chromatography
glc's - ground level concentrations
km/hr - kilometres per hour
l/s - litres per second
MAMU - Mobile Air Monitoring Unit
MP - Monitoring period
NO - Nitric oxide
NOx - oxides of nitrogen
NO_2 - Nitrogen dioxide
O_3 - Ozone
PCB(s) - Polychlorinated biphenyl(s)
ppm - parts per million
SO_2 - Sulphur dioxide
STEL - Short Term Exposure Limit
TAGA - Trace Atmospheric Gas Analyzer
THC - Total hydrocarbon compounds
TH-M - Non-methane hydrocarbons
TOP - Trace Organic Preconcentrator
TRS - Total reduced sulphur compounds
TWA - Time Weighted Average
ug/m^3 - micrograms per cubic metre
VOC(s) - Volatile organic compound(s)
°C - degrees Celsius

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